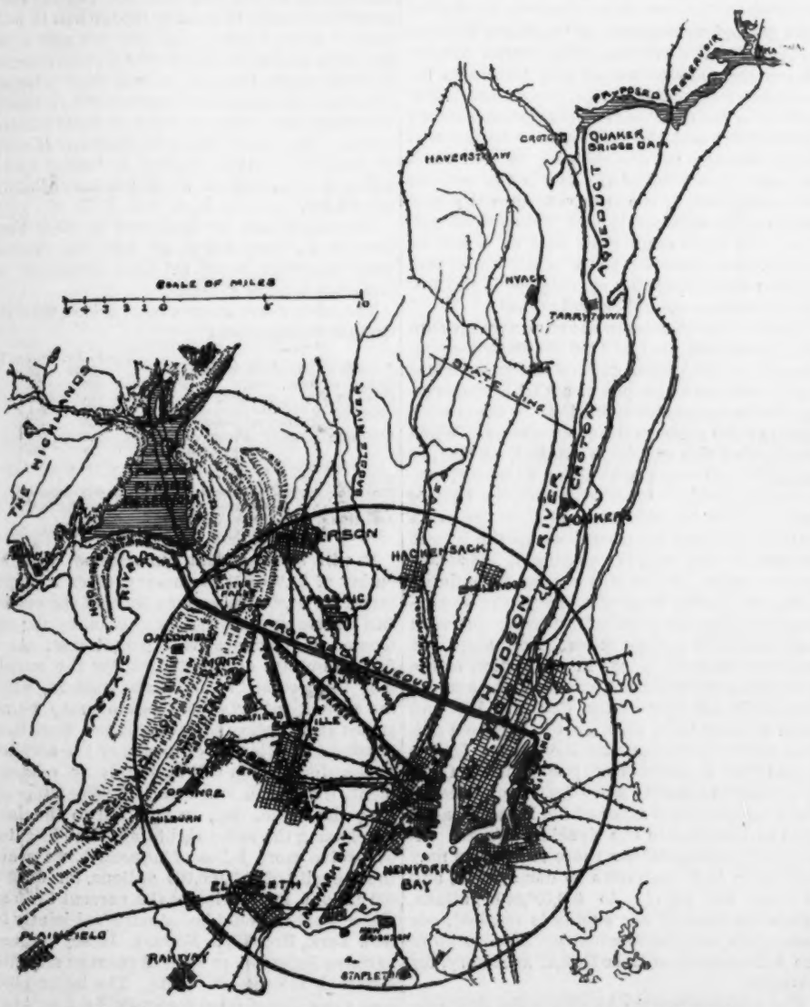
METROPOLITAN WATER SUPPLY

The water supply question, which has been so prominent y before the public of New York and adjoining cities for a few years, is a great and growing problem, well meriting the attention which it has received. Yet it seems proper to inquire whether it is not capable of a broader treatment, more in keeping with the present period of brilliant engi eering achievements. First, we should recognize the fact that our great metropolis is no longer confined to Manhattan Island alone. If from Snake Hill, on the Hackensack meadows, just west of Jersey City, as a centre, we describe a circle with a radius of twelve miles, we enclos› a population of 2,400,000 people, and a district teeming with life and prosperity, having the lower part of New York City for its business centre and focus. The whole area has the closest intercommunication and relations, and identical interests, none the less so from its lying in two different States. It is in all, save government, one city.



Map Showing the Metropolitan Water District and Proposed Systems of Supply.

This is to be the metropolis of the future, and if we would effectually meet its future needs we must treat it as a unit. That New York has 70 per cent. of this population while New Jersey has 30 per cent., may appear to some an insurmountable obstacle to all united action, but the fact that there is represented 36 per cent. of the whole population of the State of New York, and 47 per cent. of that of New Jersey, should, and undoubtedly would, secure equal consideration from each government and hence security for all joint interests.

From 1860 to 1880 the rate of increase of population in this district taken by the more prominent counties represented, was as follows: New York 45 per cent., Kings 110 per cent., Hudson 200 per cent., and Essex 93 per cent. The average for the whole district was 75 per cent., or in other words, it doubled in about 25 years. Assuming this rate of increase to continue, by 1900 the above population will reach 4,000,000, and by 1920, 7,500,000.

This population of 2½ millions is now dependent on different systems of public water supply; and so ineffectually has this subject been treated in the past, that, with the exception of a few small, insignificant works, there is not a system in operation in the district to-day which satisfactorily meets the requirements of its particular water district, and four of the largest cities are at present either looking for an entirely new supply or for means of increasing their old ones.

The small works alluded to will not only soon be outgrown but contamination from overpopulation of watersheds is inevitable. Leaving them out of account then, it is safe to say that the whole effective and satisfactory supply in what we may call the metropolitan water district, does not at present exceed 130,000,000 gallons daily, thus leaving the additional amount needed immediately, 100,000,000 gallons. With the above increase of population the supply needed by 1920, will reach at least 700,000,000 gallons daily, a quantity equal to the total yield of 1,000 square miles of watershed; or 600,000,000 gallons in addition to the present supply from the Croton, and 450,000,000 gallons additional, supposing we have utilized the whole flow from the Croton water-shed.

Sanitarians will understand that by this period a density of population will be reached which will render it imperative that this whole supply shall be brought from beyond the populous districts; from a distance, and at an expense which will be disproportionate to the means of the smaller towns. Hence these will be forced to draw their supplies from polluted and dangerous sources. The present divided action must result, then, in distress and decline of prosperity in a portion of the district. and in the cause of humanity should be abandoned. It should be evident that one general system of supply would also result in economy. No other large city draws its supply economically from a host of small works, rather than one great system; and no more can the metropolis.

Now, for a source of supply for the water so much needed, we must look to a stream which will furnish the necessary quantity, of good quality, within reasonable distance, and at as great an elevation as possible. We believe that none will be found to fulfill these conditions better than the Passaic, since, at the falls at Paterson—only fifteen miles from Central Park Reservoir, at an elevation of 116 feet above sea level—this stream discharges the drainage of 855 square miles. Enough water of excellent quality flows over these falls every year to supply several cities like New York, and frequently enough in a single day to supply that city for four months.

The contour maps, recently published by the Geological Survey of New Jersey and personal observation furnish the data used in the following computations, which aim to show the possibilities of the Passaic water-shed and its eminent fitness to be a source of supply for the metropolis.

To understand what follows, a brief description of the topography of Northeastern New Jersey is necessary.

Geologically and topographically the country is divided by a line drawn from a point on the Hudson river, four miles above Haverstraw, due southwest through Suffern, N. Y., Pompton, Boonton, Morristown and Bernardsville, into two widely differing parts. This line lies at the eastern base of the Highlands. All west of it consists of great undulating plateaus and ridges of archaean or gneiss rock, ranging from 800 to 1500 feet above sea level, a rough, wooded country, with steep rocky slopes and a scanty population. East of this line lies the Triassic or Red Sandstone plain, with elevations ranging from sea level to 600 feet above, but which for our present purposes we may consider a level plain, with an elevation of 200 feet, traversed by trap ridges from 300 to 600 feet higher. Two of these ridges, known variously as First and Second, Watchung or Orange Mountains, begin at the base of the Highlands just north of Pompton, and lying exactly parallel, and, one and one half miles apart, curve round by Paterson, Orange, Plainfield and Bound Brook, returning to the base of the Highlands at Bernardsville. These ridges form the southeastern boundary of the water-shed, which finds its outlet at Paterson. They also enclose a portion of the level sandstone plain lying along the base of the Highlands, forming a great basin, from two to ten miles in width and thirty long, with but a single outlet through the rim of trap rock. By closing this at Paterson the whole might be converted into a great lake 200 feet in depth. Indeed, from the evidence furnished, by a remarkable series of gravel terraces of corresponding elevation, it has been concluded that this was the actual condition of things, about at the close of the glacial period. In the Report of the State Geologist, for 1880, will be found a map and description of this great glacial lake, which once flooded the Passaic Valley, to a depth of 200 feet; the outlet at Paterson being closed by a great dam of drift materials. The remains of such a dam may still be seen just above the city.

This basin, subdivided by minor ridges which cross it, furnishes several admirable sites for large storage reservoirs, with catchments from 50 to 400 square miles in area, lying above on the primitive rock of the Highlands. About six miles of the northeastern end of the basin is cut off by Hook Mountain, a small ridge of trap which crosses it from east to west, enclosing a basin 21 square miles in area, known as Pompton Plains, having its outlet at Mountain View, five miles west of Paterson, at a pass in Hook Mountain, through which the Pompton river flows to join the Passaic two miles below. This pass is the gateway by which the Delaware, Lackawanna, and Western Railroad, the New York and Greenwood Lake Railway, and the Morris Canal enter the Plains. The basin is also crossed near its head, above Pompton, by the New York, Susquehanna and Western Railroad.

The Pompton river has a drainage area above Mountain View of 420 square miles It is formed near the head of the basin by the confluence of the Pequannock from the northwest, the Wan que from the north, and the Ramapo from the northeast. The water of these streams is of the best quality, and moreover always clear, cool, and pleasant to the taste. (For analysis see Report of the State Geologist, for 1876, reports of Prof. Wurtz, etc:) The population per square mile of water-shed is:—on the Pequannock 41; on the Ramapo 59, and on the Wanaque 28. It is increasing very slowly and in some districts actually decreasing. Exclusive of iron-furnaces and foundries, of which there are several, there are probably not more than half a dozen manufacturing establishments of any size on the water-shed, and no contamination from this source is worthy of note. Ninety per cent. of the area is gneiss rock the remainder being Potsdam sandstone, red sandstone and a little limestone.

The entire flow from this water-shed may be stored by building a dam across the gap

at Mountain View, and converting Pompton Plains into a great lake covering an area of 21 square miles. The elevation of the river at the gap is 168 feet. The slopes in the basin, being gentle up to an elevation of 220 feet and abrupt beyond, it will be advisable to take this as the minimum or low water level of our reservoir. It is generally estimated that 25 per cent. of the volume of the mean annual rain on a given catchment, is sufficient reservoir capacity to fully utilize the flood flows. We have long series of observations of rainfall at three points, which may be taken to fairly represent the Passaic catchment. At Newark the mean annual rainfall is 46.2 inches, at Paterson, 50.0 inches, and at Lake Hopatcong 42.5. The last being on the Highlands, like most of our water-sheds, is perhaps the safest to use. Now 25 per cent. of 42.5 inches = 10.62 inches., which, on 420 square miles, gives a volume of 10,362,000,000, cubic feet, the necessary capacity of reservoir.

By raising our reservoir to 240 feet when full, we secure a capacity of 10,493,000,000cu. ft. or ample to utilize the heaviest floods of the watershed. This gives a beautiful sheet of water 21.1 square miles in area, with bold, rocky shores, and a depth at dam of 72 feet. We secure the above capacity by uncovering but 22 per cent. of the reservoir bottom; and, as we shall presently see, we shall rarely need more than half this storage; and probably not oftener than once in ten years will we expose over 10 per cent. of the area. By building side dams to keep certain flats always flowed, this may be reduced to 5 per cent.; and this area will be pretty evenly distributed around 36 miles of uninhabited shore line, leaving the reservoir open to no valid sanitary objections. On the contrary, by relieving the remainder of the Passaic basin of the flood waters of the Pompton, which now flow large areas of flat land during wet seasons, the sanitary condition of the valley would be much improved.

Next, we will see what amount of water our catchment may be expected to furnish. The percentage of rainfall which flows down the stream from a catchment is usually estimated at from 80 per cent. for steep mountain slope, to 45 per cent. for flat, uncultivated lands. We have already seen that our watershed is favorably situated for large yield. Observations on the Croton West Branch, which corresponds closely in position and character with our area, showed the flow to be 70.98 per cent.; while on the whole Croton Basin it is 57.47 per cent.

Observations of the filling of Lake Hopatcong, which is a storage reservoir for the Morris Canal, indicate clearly a dry season flow of 23.7 inches, at least, from its 27 square miles of catchment, corresponding to an average flow of 75 per cent. of the mean rainfall. Hence, it seems safe to assume that the flow from the Pompton watershed will reach 60 per cent. of the mean rainfall. Now, 80 per cent. of this will represent the flow in average dry years, and 80 per cent. of 60 per cent. of 42.5 inches equals 20.4 inches; which on 420 square miles gives an annual yield of 148,878,000,000 allons. The following table shows, in million gallons, the amount of water flowing into our reservoir each month, and the quantity which will remain for consumption after the usual allowance to compensate riparian owners, and for evaporation and percolation from the reservoir.

The first column gives the estimated flow of the Pompton. (See foot note.) The second shows the amount allowed to compensate the riparian owners. These claimants are all below the junction of the Pompton and Passaic. Gaugings of the Passaic, made in October 1879, referred to elsewhere, indicate clearly that the minimum flow of the Pompton is certainly as low as 60,000,000 gallons daily, while the table gives a daily compensation of 146,000,000 gallons; hence, the amount allowed seems all that can be demanded. The third column shows the loss from evaporation from the reservoir surface and from percolation. The

Month.	Monthly flow. (gain.)	Compensation. (loss.)	Evaporation & Percolation. (gain.)	Consumption.	Excess.	Deficiency.
Jan.	20,470.7	4,300.8	437.2	6,825	8,818	
Feb.	81,609.7	4,390.8	510.0	7,150	6,553	
Mar.	20,470.7	4,390.8	728.3	5,850	9,502	
Apr.	17,989.4	4,390.8	1,165.5	5,525	6,908	
May.	10,545.5	4,390.8	2,104.9	5,850		1,800
June.	9,304.8	4,390.8	2,477.2	6,500		4,063
July.	4,342.3	4,390.8	2,695.5	7,800		10,544
Aug.	3,101.6	4,390.8	2,914.5	8,125		12,329
Sept.	3,721.9	4,390.8	2,112.8	6,825		9,607
Oct.	5,582.9	4,390.8	1,092.8	5,850		5,751
Nov.	14,887.8	4,390.8	728.3	5,525	4,244	
Dec.	19,850.4	4,390.8	510.0	6,175	8,775	
	148,877.7	52,679.6	17,477.0	78,000	44,806	44,094

The geological structure of the basin is favorable to small filtration. The fourth column shows the amount which may be drawn for consumption, and if drawn, the excess left to gather in the reservoir in wet months is shown in the fifth; and the deficiency to be supplied from storage in dry months in the sixth column. The total of the last is the amount to be supplied by the reservoir annually, and as the total capacity is over 78,000,000,000 gallons, but little more than half of it will be needed in average dry years, and it would supply the whole draft for six months, if the flow of the streams should entirely cease.

Now the fourth column shows an average supply, for consumption, of 6,500,000,000 gallons per month; or 213,815,000 gallons daily, sufficient for 2½ millions of people, or added to the present Croton supply for 3½ millions for the present needs of the metropolitan population. When the limit of this supply is reached, we may, at an additional expense of about $2,000,000, construct reservoirs in the balance of the Passaic watershed to supply the needs of the riparian owners, and add the quantities in the second column to our supply, making it 358,249,000 gallons daily. Better still we may, by building a dam at Lower Montville, divert the Rockaway river into the reservoir, making our total watershed 558 square miles. Now, since our reservoir capacity is less in proportion to the watershed, we will base our computations on the minimum flow of the Croton. We find thus, that we have a supply of 413,000,000 gallons daily. Sufficient with the present Croton works for 5 millions of population. Good sites may be found to store the water of the remaining 297 square miles of the Passaic watershed to compensate the riparian owners. Finally, by extinguishing these rights, we may add these last reservoirs to our system, and increase our supply to 633,000,000 gallons. When the limit of *this* supply is reached, our metropolis will be abundantly able to go to the Adirondacks or Lake Erie, if necessary, for a supply.

The works necessary to secure the first supply of 214,000,000 gallons are:

1. The removal of the D. L. & W. R. R. from the basin by changing the alignment for six miles. It may be done without increase of length or detriment to the alignment.

Three and one-quarter miles of the Morris Canal must be rebuilt. No engineering difficulties are involved.

Of the New York and Greenwood Lake Railway, nine miles would have to be rebuilt.

The N. Y. Susquehanna and W. R. R. would be slightly shifted or raised for 3¾ miles.

A dam 2,400 feet long and 80 feet in height, with tunnels, waste-weir and accessory works, would be required at Mountain View. The situation is such that an ample waste-weir may be built at a low side dam on the solid rock of Hook Mountain remote from the dam, and outlets may be had by tunneling the same ridge. Hence the dam may be a plain, heavy earthen embankment; built, of course, with every precaution but subject to less than the usual dangers of such works. However, a masonry dam might readily be substituted.

There would be 14,000 acres of arable land, swamps and rough mountain land flowed.

The works are estimated to cost as follows:

Railroad and canal diversions	$505,000
Dam and accessory works	1,162,000
Land damages	1,400,000
Total	$3,067,000

For which we can store 148,878,000,000 gallons, which is at the rate of $20.60 per million gallons, or if we take only the net supply of 78,000,000,000 gallons, it is at the rate of $39.32 per million gallons. The cost of storing water on the Croton catchment has been, since 1865, $174.00 per million gallons, and in the Quaker Bridge plan it will be $125.00 per million gallons. But the above water is available at a distance of 19.12 miles from the Central Park reservoirs, while to Quaker Bridge will be 31.35 miles. If we suppose the cost per mile to be the same and allow $2,000,000 for extra expense in crossing the Hudson, we still have a saving effected in the aqueduct of $5,000,000, or nearly $2,000,000 more than we need to build our reservoir. But closer estimates, based on 11 miles of masonry conduit, partly in tunnel and 8 miles of pipe, indicate a possible cost of about $13,000,000.

The water may be delivered in New York City at an elevation of 180 feet, the Central Park reservoir being 115 feet, giving an increase in head of 65 feet.

The table below gives a comparison with the Quaker Bridge plan:

	Quak. Br.	Pomp. Pl.
Length of aqueduct, miles,	31.35	19.12
Height of dam, feet,	200	72
Head in New York, feet,	115	180
Capacity in million gals. daily, without compensation,	250	314
Ultimate capacity of reservoir, " " " system,	250 270	513 733
Including in both plans the 100,000,000 gals. of the present Croton system.		
Storage provided mil. gals.,	32,000	149,000
Cost of works, first capacity,	$19,500,000	$16,500,000
Additional cost of raising supply to 513,000,000 gals.	?	$13,000,000

It will be seen that our scheme, with an outlay of $3,000,000 less money, gives a supply larger by 64,000,000 gallons daily at the outset. But its strong point is, its capability for extension at comparatively small cost. At a further outlay, of about 2,000,000, the supply may be increased to 458,000,000, gallons, while the capacity of 513,000,000 gallons, may be attained at an outlay of probably not more than $5,000,000 additional, exclusive of the addition to aqueduct, which will be simply an enlargement, the length and location remaining exactly the same. By, in addition to the last, purchasing the water-rights, and building ten or twelve more miles of aqueduct, we reach the capacity of 733,000,000 gallons, (or 633,000,000 gallons, in addition to the present Croton.) These works should be constructed jointly by New York, Brooklyn, Newark, Jersey City and perhaps Paterson, or such of them as may find it to their interests to unite. The latter place may draw direct from reservoir, by a separate conduit 5 miles long, a gravity supply with 20 feet more head than its present works furnish. For the remaining cities the main conduit may be carried through First Mountain, emerging at an elevation of over 200 feet near Montclair Heights, where pipe lines may diverge to Newark and Jersey City, both of which places, save a very small high service district in each, will be supplied by gravity. The main conduit will continue direct to Central Park reservoir. Thence pipes may continue across the East River at Astoria, to Brooklyn and the Long Island towns. Arrangements may be made for the many smaller towns in New Jersey, to tap the main conduits for a proper consideration. Must not such a system have an immense and increasing advantage over the multitude of small and inefficient works of the present methods of procedure, both in economy and in aiding to secure the blessings of healthfulness and con-

tinued prosperity throughout the district, which is to become the metropolis of the twentieth century?

C. C. VERMEULE. C. E.

NOTE.—In order to assist the reader to a conception of the value of this great quantity of water, at an elevation of 220 feet. We will note the fact that if the total yield of the Pompton Plains reservoir should be conducted to the face of the mountain, in West Paterson, by a conduit five miles in length, and the water utilized for power at the same rates as now received by the Society for the Promotion of Useful Manufactures, of Paterson, or its mill privileges, it would yield the interest on $26,000,000. If worth so much for its weight alone, taking into account its purity and wholesomeness, what should we value it at as a supply for domestic consumption.

NOTE.—We will fortify the estimates of flow from the results of a minimum gauging of the Passaic River, made by J. J. R. Croes, C. E., and Geo. W. Howell, C. E., in October, 1879. (See Report to Newark Aqueduct Board in Additional Water Supply.) The rainfall for this month at Newark was 0.32 in., less than recorded in any previous month for 37 years, the next higher being 0.61 in. Added to this the temperature for the month was the highest recorded in October, for a like period. Under these unfavorable conditions the flow was found to be 126,334,000 gallons per day, and the stream remained stationary for 12 or 14 days, showing that it had felt the full effects of the drought. This flow was at the rate of 64 per cent. of the rainfall for the month, and implied a flow from the Pompton watershed of 1,832,000,000 gallons; the area of the Passaic catchment being, above the point of gauging, 855 square miles. If we assume that the percentage of flow was the same for the next dryest month in 37 years, the flow from the Pompton would have been 3,724,000,000 gallons, or 623,000,000 gallons more than we have estimated for the dryest month in the reservoir table, which is not calculated for the dryest year, but for the average dry year, with a rainfall 80 per cent. of the mean. The reservoir capacity being sufficient to supply the whole demand for six months, if the flow of the streams should cease entirely, it is sufficient to tide over such extremes as the above.

SPECIFICATIONS QUAKER BRIDGE DAM.

Showing the General Method by which it is Proposed to Excavate and Prepare the Foundations, and to Erect the Superstructure—and at the same time to Provide Means for Getting rid of Freshet Water During the Progress of the Work.

The work will conform to the lines, levels, bounds and stakes as laid off and determined by the Engineer, as shown in the accompanying plans and sections, and in conformity with instructions and detailed drawings received from him from time to time.

Dimensions.—In general, the length of the course of the dam at the coping will be 1350 feet, and the width of crown 22 feet, the length of dam at datum level (40) will be 510 feet, and the width at that level will be 172 feet. The length of the top of foundation at datum level (16) will be 385 feet, and the width at that level will be 200 feet, while the lower course of the superstructure at level (16) will be 185 feet, and the height from that course 192½ feet to the crown.

Quantities.—The approximate quantities are as follows:

Excavation of Earth (foundation)	175,000	c. yds.
" " Rock "	15,400	"
Concrete Masonry of "	158,000	"
Masonry of Superstructure	287,000	"
Relieving Arches	7,000	"
Timber, Bulkhead and Flume		
Cornices and Parapets	1,600	"
Contingencies 10%		

Classification of Excavation.—The material excavated from foundation pit, will be classified as follows—Earth and Rock. By earth is meant all material encountered in the excavation of whatever quality it may be, except rock. By rock will be understood all material requiring blasting for its removal, and measuring over one-half a cubic yard.

Prices.—The price of excavating in each case, will include the cost of excavating, hoisting and hauling the material, and depositing the same as directed within an extreme distance of 1,000 feet, together with all expenses incident to the employment of laborers and tools, and machinery requisite to the attainment of the end in view, and keeping the pit free of water during the operations.

Work to be Done.—The work to be done under this specification will embrace the excavation of all material on the site of the dam within the outlines marked on the plan, and extending in depth to the bed rock, and its removal to points indicated by the Engineer. The preparation of the rock surface to receive the concrete, and the clearing out and filling with cement all fissures in the Rock.

The completion of the concrete masonry foundation from the bed rock to the level datum (16) and the completion of the substructure thereon as specified to datum level (40) of coursed rubble masonry, and also the rough hammered arches within their levels, and completing the superstructure of uncoursed rubble, thence to the crown of the dam; and setting the rough hammered cornice work, and corbels, as her plan, and completing the parapet wall and coping, agreeable to the general plan and details to be furnished by the Engineer.

Foundations.—Briefly, the method of carrying on the foundation will be to coffer dam one half of the river bottom, excluding the river, excavating and building within, then turning the channel over the completed half of the foundation, coffer dam the remaining half, and excavating and building as before.

A trench 30 feet in width, or as may be considered necessary, is to be opened at right angles to the axis of the dam, and extending from north to south, the extreme width of the proposed excavation, and carried down to the bed rock, and sheet piled in heavy timber panels, properly strutted within and braced, forming a tight coffer dam, which after excavating within will be filled with concrete masonry.

A similar coffer dam, with concrete filling, can be extended on the south side, or a braced timber support properly shored, may be considered sufficient; thus enclosing the space in a concrete filled coffer dam, carried up with timber to safe level for freshets and filled with concrete but to the level of say (30).

Temporary Dam.—The material excavated to be first utilized in damming the river, and directing and confining the channel to the opposite half of the river bottom at this place.

When the first coffer is completed, the space within shall be excavated to the bed-rock, the earth disposed in spoil as directed, and the boulders and rock broken into manageable masses for use, after the completion of the excavations, and a proper preparation of the surface of the bed rock, by roughly stepping the rock into benches whenever its natural surface is on too steep a slope, and closing all fissures with cement mortar, the entire space.

Foundation Masonry shall be filled in with concrete masonry, in which the large split boulders shall be thoroughly bedded; the excavation and filling with concrete may progress simultaneously, and carried up to level (16), on the top of foundation, finishing the same with heavy split boulders as a top course. From this level, to datum (26), the substructure courses shall be carried up in heavy coursed rubble masonry, laid in full beds of cement mortar further specified elsewhere, and carefully and thoroughly filled with spauls, so as to make tight and solid work.

Substructure Masonry.—The stone for this part of the work shall be selected for dimensions and soundness, or the best obtainable granite or gneiss, which the locality affords, and acceptable in every respect to the Engineer.

The general dimensions of the stones for this substructure of the dam, will be large blocks to be set by derrick, averaging in general from 16" to 24" square, and from 4 to 6 feet in length, of a generally square section as split from the quarry, without dressing, nor the joints squared, further than to be roughly squared by the hammer, or pointed off, and the stone shall average not less than ½ of a cubic yard, unless in the shape of spauls to pin the joints, and level up the courses, which shall be from 2 to 3 feet in depth; one shall be taken to bed the end joints of the respective courses as they join the bed rock on each side of the valley, into a recess cut in the rock to a depth of 16' at least.

This recess may be roughly cut in benches and need not be of uniform section.

When the eastern half of the foundation to datum level (16), and the substructure as above explained has been carried to datum level (24), and the piers between the relief openings established, in the same description of work, the trench A, B, shall be extended to bed rock on the bottom and western side, and after excavating within, and shoring, bracing, and timbering, as before, the remaining space A, E, F, G, shall be enclosed by the coffer dam as the first half had been, and the material excavated being used to divert the river channel over the part of the foundation already completed; the excavation shall proceed in this half, and the space filled in with concrete masonry and large split boulders in the manner as previously specified, to datum level (16), and the substructure of the dam carried up to datum level (24), when the piers for the relief openings or arches for this latter half, having been established, the foundation of the main dam is complete, and exit afforded through the relief openings for the run of the river.

Timber Flumes.—It should be remarked in this connection that to preserve the relief openings from injury from the current of freshet water, each of them shall be lined with a 4 inch plank, and framed timbered flumes extended throughout the entire length, through the walls of the centre of the dam, and properly connected with a temporary dam to direct the current into their upper ends, and also discharging sluices of framed plank from their lower ends down stream, as the nature of the surroundings may render necessary in order to discharge the water at a lower level to be determined on.

Relief Openings.—These openings, 18 in number, of a circular section 3 feet diameter, according to plan marked B, and 24 feet between centres, shall be constructed of hammered granite arch stones 2 feet deep, cut to radial lines, 16 arch stones to the circle, with square head as per plan; the three invert stones of each arch set on the datum plane (24), the whole in full beds of cement and properly keyed and truly set and bonded to the adjoining courses as shown. (For possible reduction of the number of these arches, see article "Filling Arches.")

The same system of bonded headers and stretchers being carried up throughout the intervening piers, and over the square heads of the arch stones to the datum level of (40), where this method of construction will terminate by being bonded into the bed rock on each side of the valley.

The centres of these arches shall be of treble thickness of 8 inch sound pine plank, with lappping and chored pieces properly secured, according to plan furnished by the engineer, with folding wedges of hard wood for easing the same.

Relief Arches.—In the construction of these arches, which will be about 185 feet in length, at intervals to be determined on, a ring of the arch stone shall be cut 3 inches slack on the intrados, so that a ring of arch stones at these intervals, without reference to the length of the arch stone in the course, shall have their intrados on a circle of 8" 6" diameter.

This shall refer to the invert arch stones, as well as to the arch proper, in order to furnish a key or bond for the bearing of the ultimate filling in of the arches on the completion of the dam.

The face rings of these arches shall measure in the length of the course at least 4 feet, and

as well as the remainder of the courses shall break joints at least one foot. This ring stone will be roughly hammer-dressed to pattern, with about a ¾ inch joint, and will be truly set in full beds of cement. From the datum level (40) the wall shall be laid to line, and timber profiles, or templates, as follows:

Main Dam.—The facing stones normal to the curve or slope shall be laid to a depth of 4 feet; in courses of range work from 18 to 24 inches rise, being selected stone of an approximately square section, with joints carefully filled in with spauls driven by the hammer, with full beds and joints of cement so as to secure solid and tight work, but without dressing of any kind further than the natural split face of the stone.

Within this facing, which will be carried up uniformly with the remainder of the work, the entire heart of the dam, up to the crown level shall be of uncoursed rubble, of size to lay without derrick, and filled close with spauls driven by hammer in full beds of cement, but regardless of courses or special bond, being in fact rough quarry rubble work laid in full beds and joints of cement, tight and solid. The work carried up uniformly, no part being allowed to extend 2 feet in height above the remainder, but as before remarked, the work will not be carried up with any regard to regular courses, but the stone of medium size, of in general about 1 to 2 cubic feet, will be laid as they come from the quarry with their quarry faces. No surface or weathered stone will be allowed, nor will any effort be made for square joints, but the effort will be to insure as uniform and close fitting mass as possible of stone and cement, without any openings or vacuities. but filled in solid with spauls and full beds of freshly mixed cement mortar.

Every cubic yard of this part of the work should be in proportian of about 18 cubic feet of stone and 9 cubic feet of cement mortar.

It will be perceived that there are three methods of construction contemplated in the masonry of this dam and its foundations.

1st. The foundation proper, from the bed rock to datum level (16) will be of heavy concrete interspersed throughout with split boulders of irregular figure, fully bedded throughout in the adjoining mass of concrete, but without any attempt at laying the same in any recognized method of bonding, but simply for the rough stone to be enveloped throughout in the concrete, and without any vacuities whatever.

2d. From top of foundation datum level (16) to datum level (24), and in order to equalize and distribute the superincumbent weight over the foundation in the best manner possible, the masonry between these levels, called the substructure, will be of coursed rubble, and will consist of stone as large as can be conveniently handled, but not square jointed, though of generally flat bed, the joints well filled with spauls, and well breaking joints and bonded, the courses leveled up to a generally uniform height, and carried on as uniformly as possible over the entire area, and this same method of laying flat stone, and courses levelled up, will be continued in piers and over the arched outlets up to the datum level (40).

3rd. From this level of (40) to the crown of the dam (level) the masonry will consist of uncoursed rough quarry rubble, laid in full beds of cement, and as nearly homogeneous throughout as possible—as specified.

The prices bid for the work will be under the following heads and items:

1st. Excavation of foundation in earth.

2nd. Excavation of foundation in rock.

These items will embrace the entire cost of excavation, including timbering and coffering, shoring, pumping, etc., and estimated by the cubic yard taken out and disposed of as specified, and also the excavation of the wings or sides will be embraced under this head, and the preparation generally of the foundations.

3rd. Filling the foundation pits with concrete and split boulders from the bed rock to datum level (16) including all expense incidental to keeping the pit free of water. The sheet piling being left within the concrete at per cubic yard.

4th. The coursed rubble substructure between datum levels (16) and (40), embracing the filling of the outlet arches to be noted subsequently at per cubic yard.

5th. The hammered arch stones of the outlet arches complete, including centres and bonding with the adjoining courses, per cubic yard.

6th. The uncoursed rubble superstructure of the dam, including the facing stones from datum level (40) to the crown of the dam, with all incidental expenses, per cubic yard.

7th. The hammer dressed corbels, and corbel arches, cornice and parapet walls, set complete per cubic yard.

8th. The coping of rock face work with drafted arises set with cement, and dowelled joints, complete per running foot as per pattern.

The above classification of items of materials and work, will embrace every item of expense incident to the completion of the respective descriptions of work, and unless by the written order of the Chief Engineer no bills for extra work beyond the contract prices for the above items will be considered. The completion of the roadway not being included in these specifications.

Cement.—The integrity of this work will depend largely upon the quality of the cement used, which must be of an approved brand, and in tight casks stored by the contractor under cover and well protected from the weather.

Every cargo of cement shall be inspected, and samples taken at random shall be tested for tensile strength, and a record kept agreeably to the custom on public works, and cements which fails to come up to the test imposed, shall forthwith be removed by the contractor.

In mixing the cement for use, which operation shall be under the constant supervision of a foreman approved by the engineer, one volume of cement shall be mixed dry with two volumes of clean, sharp, moderately coarse sand, the water shall then be added, and the whole thoroughly mixed for immediate use.

No cement which has become partially set shall be allowed to be used, neither shall cement which has been mixed over an hour, or become partially set, shall be allowed to be used, neither shall cement which has stood the test of samples, but sets imperfectly in the wall be accepted; but masonry exhibiting such defect in any degree, shall be taken up and relaid at the contractor's expense.

Sand.—The sand shall be sharp and moderately coarse, and free from loam or foreign ingredients or dirt of any kind, and if need be, shall be washed and dried before use.

Concrete.—The stone broken for concrete shall be sound, and broken to a size not exceeding 2 inches in any direction; four parts of such broken stone to three parts of cement mortar, or cement one part, sand two parts and broken stone four parts, shall be the proportions of the concrete, unless circumstances in the judgment of the engineer shall call for a change in these proportions.

Immediately after mixing it shall be deposited in place and uniformly spread in layers not to exceed 9 inches in thickness; the previous layer shall be broken or wetted to form the union of the layers, and where large stones are bedded there shall be a layer of cement interposed, and the concrete shall be rammed around the stone, and every precaution taken to insure a perfect contact, and the filling up of all vacuities.

All materials and workmanship will be subject to inspection, and deficiencies and defects made good at the contractor's expense—and all detailed instructions of the engineer in the spirit of these specifications will be regarded as part and parcel of them.

Profiles.—The timber profiles and lines set up as guides for the surface of the walls will be strictly followed, and the expense of setting them will be included in the contract prices.

Care will be taken to preserve the stakes and bench marks set out by the engineer.

Filling Arches.—When the work has reached the crown level a small coffer dam shall be set up in front of each of the relieving arches, and the timber flume being removed, and the invert cleared of all sand or other loose material, the workman shall proceed to fill up the arches with uncoursed rubble of a description similar to the heart of the main dam, commencing at the head wall with a full bed of cement, into, and with which the stone selected for this purpose shall be solidly and tightly set with hand hammers, observing to fill out thoroughly the three inch space left at intervals by the enlargement of the intrados circle of the ring stone alluded to in the specification of the relieving arches. This work will be carefully done so as to result in a water-tight bonding between the arch stone and the rubble filling. The number of these arches may be reduced by omitting every alternate arch, should the engineer so determine, as shown on exhibit F.

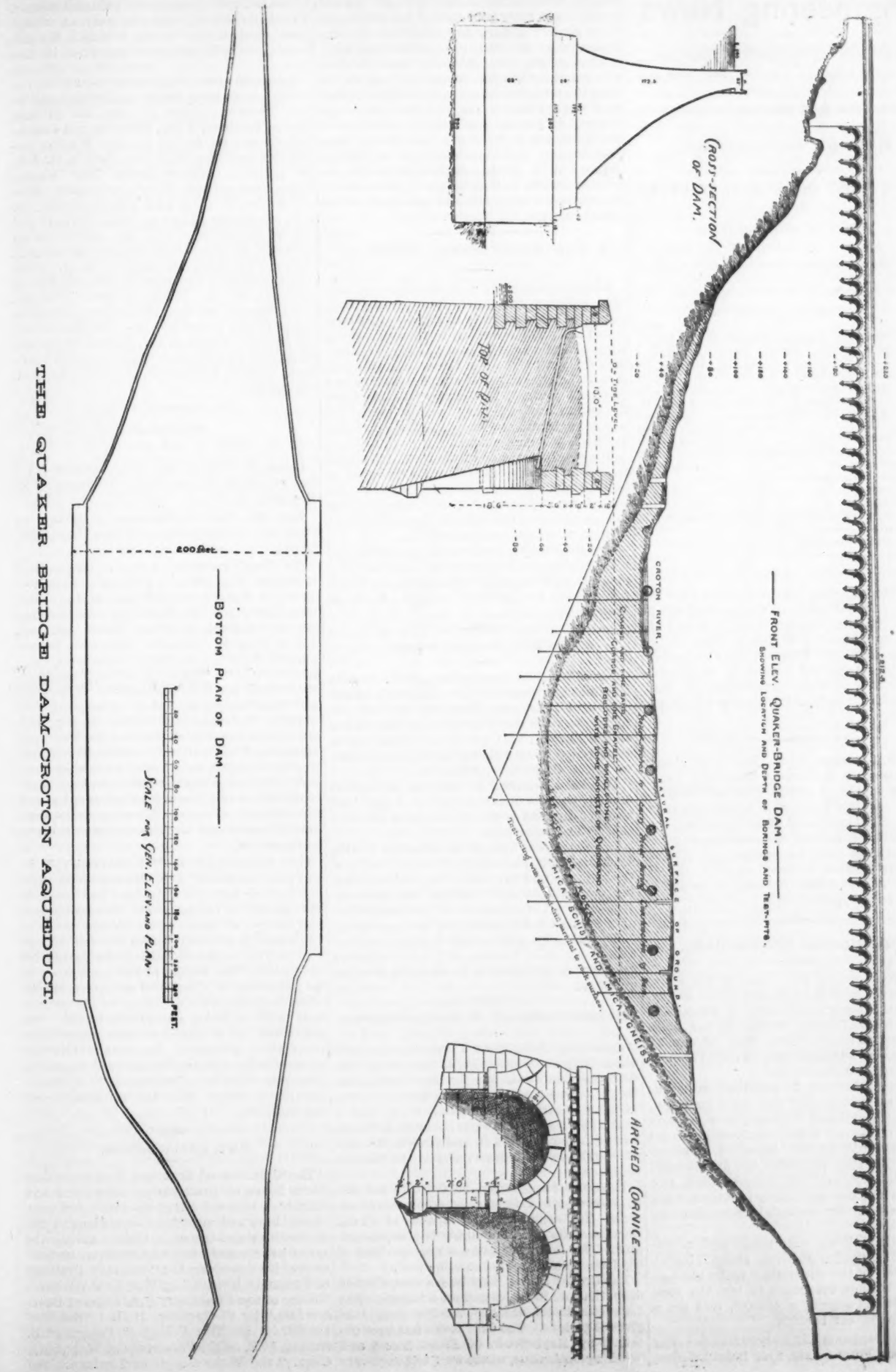
Pointing.—The face of the entire work above datum levels (16) shall be well and carefully flush pointed as the work progresses, and this pointing renewed from time to time as may be found necessary. The cement mortar for this purpose being freshly mixed with equal volumes of cement and sand.

Roofing.—After the completion of the foundations substructure to datum level (40), the work will be roofed in to protect it from the weather, and this roofing will be shifted and efficiently maintained as the dam increases in height.

Lighting.—The work on the foundations will proceed day and night, and electric or other lights will be disposed so as to enable the workmen to operate to advantage.

Police.—A strict police force will be preserved at all times on the work, and the contractor will be held responsible for any injury which the adjoining property may sustain by reason of any neglect in this respect, and no spirituous liquors will be allowed to be sold or used on the premises.

Harper's Magazine for May will conclude the sixty-eighth volume of that now venerable, but never aged, periodical. Howard Pyle, author and artist, will lead the number with a frontispiece and two other charming full-page pictures illustrating "A May-Day Idyl of the Olden Time," a quaint, old-fashioned love-story, told in letters. The fine-art feature will be another of the "great pictures" engraved by Closson—this time Titian's "Belle." The heroes of the number are the Emperor William, a careful study by Bismarck's biographer, Dr. Busch, and Dr. Schliemann, of whom Prof. Mahaffy writes; there are fine portraits of both, as well as of President Monroe, Rufus King, and Henry Clay, in connection with Col. Higginson's paper on the "The Era of Good Feeling," as he calls Monroe's administration. Travel includes a description of the holy city of Kairwan, in Tunis, by A. F. Jacassy, one of the first Europeans to visit it, who also illustrates his own paper; and the second of the papers on the Fraser to the Columbia regions, by Ernest Ingersoll; Mr. Rideing also presents a study of the Bank of England, which will interest every business man, as well as those who like to read of "foreign parts." The serials by Wm. Black and E. P. Roe will present more of the delightful illustrations by Abbey, Dielman, and Gibson; and Alfred Parsons will illustrate in his charming way the first of some poems of a new kind, "Transcripts from Nature," by William Sharp. Among the non-illustrated articles will be a thoughtful paper on the control of the dangers from defective vision, by one of our leading oculists, Dr. Jeffries; a study of "The Thunderer of the Paris Press," *viz.*, the *Journal des Debats*; an amusing story by Brander Matthews, "The Rival Ghosts," and a number of poems.



THE QUAKER BRIDGE DAM-CROTON AQUEDUCT.

Engineering News

AND

AMERICAN CONTRACT JOURNAL.

Tribune Building, - - - New York City.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

PUBLISHED EVERY SATURDAY.

CONDUCTED BY

GEO. H. FROST and D. McN. STAUFFER.

TERMS OF SUBSCRIPTION:

$4.00.....PER YEAR TO U. S. AND CANADA.
$5.00..... " " " FOREIGN COUNTRIES.

Make all drafts, cheques and money orders payable to ENGINEERING NEWS PUBLISHING CO.

TABLE OF CONTENTS.

	PAGE
Metropolitan Water Supply, (Illustrated)	169, 170, 171
Specifications Quaker Bridge Dam (Illustrated)	171, 172, 173
The Quaker Bridge Dam	174
A New Engineering Journal	174
The Both Dredging Bucket	174
Artesian Wells in Philadelphia	174
Personal	174
New Publications	174
American Society of Civil Engineers	175
Hunting Cholera	175
Staking Out (Illustrated)	165
Correspondence	175, 176
The Ohio Floods	176
The History and Statistics of Amer. Water Works	167, 177
Water	177, 178
News of Week	178, 179, 180
Markets	180

THE First Regular Meeting of the Civil Engineers and Surveyors of Connecticut will be held on Tuesday, the 15th inst., at 10.30 A.M., at 87 Church street, New Haven, Conn. An interesting meeting is expected and all members of the profession are invited to be present. The President of the Association is B. H. Hull, well known throughout the State as a hydraulic engineer.

OLIN H. LANDRETH, C. E., Prof. of Engineering, Vanderbilt University, Nashville, Tenn., has just published a little book of "Metrical Tables" on the basis of 1 meter = 39.370432 inches, and 1 gram = 15.43234875 grains. Students' Edition, printed on parchment paper folded in book form for pocket, price 35 cts. Engineers' Edition, mounted on cloth, dissected, may be suspended on wall, or folded in case for pocket, price 75 cts.

THE QUAKER BRIDGE DAM.

The specifications and plans of the above work, published this week, are those accompanying the report of Hubert O Thompson, Commissioner of Public Works, to the Aqueduct Commissioners, under date of Jan. 30, 1884, and are supplementary to Mr. Thompson's report of August 8, 1883.

These plans should be regarded rather as studies submitted for this very important work, than as finished working drawings, ready for the contractor's use, as they have yet to be approved by the Aqueduct Commissioners. But they do exhibit the location and general dimensions of the proposed dam, and the care which has been taken in ascertaining the nature of the material underlying the foundations.

The borings shown were made with a diamond drill, bringing up cores, about 1¼ inches in diameter, of the underlying rock; the two diagonal borings were made to test the rock for fissures and general character, and are a new feature in test borings.

This proposed dam is in its type modeled after the famous Furens dam, near Saint Etienne, France, commenced in 1858. But the Furens is only 175 ft. high from base of foundation to water surface in dam, and about 328 ft, long measured on the crest; the underlying rock is mica schist, much the same material that is found at the Quaker Bridge site. As shown upon the cross section given the Quaker Bridge dam will be nearly 100 ft. higher than the Furens, at present the highest structure of this character in the world, and nearly four times longer. The great depth of foundation required in the present dam, is a feature requiring careful and elaborate study and the consideration of an element not found in its great prototype, the Furens.

A NEW ENGINEERING JOURNAL.

Among many other new departures in railroad building, the South Pennsylvania Railroad now has a monthly magazine of its own, edited and published solely by the enterprising engineers who have its construction in charge. The introductory to No. 1 disclaims all intention to the production of either a literary or a scientific journal, but charges its inception directly to one of those "Strange freaks for which engineers are famed." The chief end in view is self amusement.

Knowing somewhat of the many jolly-good fellows and really talented fellows who are to be found among these modern "martyrs to the stake," we expect some "good things" from this new literary venture. We hope the editors will put us on their exchange list.

Our engineering readers will appreciate the very graphic, and too often true "staking-out" incident, detailed upon another page, for which our scissors are indebted to the *S. P. R. R. Transit.*

The Both Dredging Bucket.

One of the Both patent Clam Shell buckets mentioned on page 246, Vol. 10 of this journal, now used by Messrs. Ross and Sanford, the contractors for dredging the Potomac Flats at Washington, D. C., proves to come up in every respect to the claims made by the inventor Mr. A. C. Both, Portland, Me.,

The hard material is dredged with great facility, and the bucket brings up a full load at every dip, and works to the entire satisfaction of the contractors.

The bucket was built by the Atlantic Works, East Boston, Mass., under the supervision of the inventor and the owners, and other dredging men and bucket builders, who have inspected it, all pronounce it to be unquestionably the best built bucket they have ever seen.

We shall soon give to our readers, an illustration of this bucket, and more detailed information in regard to its superior working qualities.

ARTESIAN WELLS IN PHILADELPHIA.

According to the Phila. *Press.* there are now about fifty artesian wells in that city. The first one put down was for the Continental Hotel, a well 247 ft. deep, 8 in. diameter, and yielding 75 gallons per minute. Since then a well sunk for the brewers, Bergner & Engel, reached a depth of 576 ft. and flows at the rate of 140 gallons per minute; this is the deepest in the city.

The price ranges from $3.50 to $12 per lin. ft., according to diameter and other considerations. The estimated daily capacity of all the artesian wells in Philadelphia is 4,000,000 gallons. The following gives a general idea of the location and yield of existing wells:

The United States Mint has a well, 458 feet deep, that produces 140 gallons a minute. The Lafayette Hotel has one, 212 feet deep, that gives 60 gallons. The best result has been obtained by Heyl Bros., of Front Street and Washington Avenue, whose well, although only 72 feet in depth, produces 300 gallons a minute. The Aldine Hotel draws 60 gallons a minute from a well 171 feet deep. Powers & Weightman's well is 300 feet deep, and gives 160 gallons.

Among the other wells of the city are the following, with their tested capacities per minute: Ridgeway Park, 216 feet, 100 gallons; Hance, Brothers, & Co., Marshall and Callowhill Streets, 187 feet, 50 gallons: William Sellers, Sixteenth and Hamilton Streets, 187 feet, 160 gallons; Conyers Button, East Walnut Lane, Germantown, 350 feet, 100 gallons; Morris & Tasker, Fifth and Tasker Streets, 400 feet, 160 gallons; Thomas Dolan, Howard and Oxford Streets, 418 feet, 160 gallons; John Gardner, Twenty-first Street and Washington Avenue, 340 feet, 188 gallons; F. A. Poth, Thirty-first and Jefferson Streets, 500 feet, 30 gallons; W. H. Nixon, Twenty-fourth and Vine Streets, 300 feet, 120 gallons; Delaware Sugar House, Front and Reed Streets, 90 feet, 120 gallons; Bartol & Co., Eighth Street and Passyunk Avenue, three wells, 76 feet, 300 gallons; Malcom Lloyd, Gibson's Point 300 feet, 100 gallons.

PERSONAL.

OSCAR H. PEACOCK has been appointed, for the fifth term of two years, City Surveyor of Rochester, N. Y.

THE RIO GRANDE WESTERN CONSTRUCTION COMPANY'S headquarters are Salt Lake City, Utah.

MR. EMIL KUICHLING, Assistant Engineer of Rochester Water Works, N. Y., arrived in New York on Sunday evening last, in the *Spain* from Liverpool. Mr. Kuichling has been absent four months, and has visited Antwerp, Aix la Chapelle, Cologne, Hanover, Berlin, Leipsic, Frankfort-on-Main, Darmstadt, Carlsrhue, Strasburg, Mayence, Metz, Dusseldorf, Rotterdam, London, Birmingham, Liverpool, and Manchester, on a tour of inspection of works of Sewerage and Water Supply, with special reference to the needs of the New York State Board of Health, by which Mr. Kuichling is frequently retained as consulting Engineer. Mr. Kuichling has made a special study of the physics of Water Supply for cities and the disposal of sewage, for some years past, and paid particular attention to these subjects while abroad.

C. C. VERMEULE, C. E., New Brunswick, N. J., has been connected w th the Geological Survey of New Jersey for the past five years, in the capacity of topographer. The topographical surveys of which he has charge are to be vigorously prosecuted during the coming season, and he is now organizing the parties for field work. The results of the surveys are to be published in a series of seventeen sheets, with contours, scale one inch to a mile, the first three of which appear this spring. The maps will be of great economic value aside from their geological importance and are already being constantly consulted in all engineering operations, but especially for water-supply on which they are throwing much needed light.

NEW PUBLICATIONS.

The Sixth Annual Report of the Connecticut State Board of Health is an interesting and valuable document. It is especially full upon the sanitary and unsanitary conditions of different cities and towns in Conn. Among the many papers and extracts making up its bulk of over 400 pages are the "Sanitary Drainage of Tenement Houses" by Wm. Paul Gerhard; "Some of the Unsanitary Conditions of Country Life," by C. Gardner, M. D.; "Sanitary Conditions at Yale College;" Report of R. Hering, C. E. on the "Sewerage of Waterbury, Conn.;" the Water Supply of Torrington and

Wallingford; The Bridgeport Hospital, etc. Many of these reports are illustrated by maps and plans. The report of the Bureau of Vital Statistics for the year ending Dec. 31, 1882 is embodied in the volume.

American Society of Civil Engineers.

APRIL 2ND, 1884.

The Society met at 8 P.M., Vice President Wm. H. Paine in the chair; John Bogart, Secretary.

Ballots were canvassed and the following candidates elected:

As Members: Thomas W. Baldwin, Bangor, Me.; Thomas E. Brown, Jr., New York City; Oren B. Colton, Chicago, Ill.; Stewart Derbishire, Aylmer, Canada; Joshua L. Gillespie, St. Paul, Minn.; Minard L. Holman, St. Louis, Mo.; William T. Jennings, Toronto, Canada; Henry F. Juengst, St. Joseph, Mo.; Moritz Lassig, Chicago, Ill.; John F. O'Rourke, New York City; George W. Rafter, Fredonia, N. Y.; Irving A. Stearns, Wilkesbarre, Pa.

As Juniors: Frank E. Bissell, Sedalia, Mo.; Joseph A. Powers, Lansingburgh, N. Y.; Commodore P. Ruple, Wilson's Point, La.; William H. Starr, Buffalo, N. Y.

A paper by the late Wm. R. Morley, M. Am. Soc. C. E., on the Proper Compensation for Railroad Curves, which had been read at a previous meeting of the Society, was discussed.

Mr. A. A. Robinson, M. Am. Soc. C. E., stated that the location of the New Mexico Extension of the Atchison, Topeka and Santa Fe. Railroad was made with the standard of compensation based upon the theory that each degree of curvature was the equivalent in resistance to the movement of trains of $\frac{5}{100}$ of a foot of ascent. After the construction it was found, first, that upon maximum gradient 0.6 per cent. where a full train was 30 to 32 loaded cars, this compensation was hardly sufficient; second, upon maximum gradient of $1\frac{13}{100}$ per cent. with full train of 18 to 20 cars, it was fully sufficient; third, upon maximum gradient of 3.4 per cent. with full train of 7 to 8 cars, it was evidently greater than was needed. Mr. Robinson considers that the resistence due to curvature is affected by so many conditions that it cannot be determined by mathematical formula, except for the particular conditions assumed in a special case. The speed of the train, the elevation of rail, the greater length of outer rail, the guage of track as compared with that of the wheels, all affect the question, and the resultant of all the forces will be a function not only of the rate of curvature and of the gross tonnage of the train, but also of the number of cars in the train. A train of 10 cars will produce a resistence greater than 10 times that of a single car. Upon a division of the railroad, where locomotives can pull 30 cars, the rate of compensation should be greater than upon a division where engines can pull but 10 cars. In practice, Mr. Robinson has adopted the following rules for compensation:

Rate of max. grade	0.0 to 0.6	per 100'	com'sat'n	0.06	per 100
" " "	0.6 " 1.6	" "	"	0.05	" "
" " "	1.6 " 3.0	" "	"	0.04	" "

Mr. Wm. H. Searles, M. Am. Soc. C. E., discussed, mathematically, the nature and amount of the increase of resistance on curves due to the increase in number of cars upon a train, and deduced a general formula for the total tractive force necessary to be applied at the head of a train of cars moving at a uniform velocity on a given curve, and presented tables giving the coefficient for solving such formula in terms of the number of cars and the degree of curve. He also presented tables of resistances for given trains upon certain grades, and a summary of equivalent grades per station per degree for a given train upon various curves and grades. Also a table of resistances for a consolidation engine of 60 tons hauling its maximum train on a 20 degree curve. He also expressed the opinion that widening the guage on curves was not an advantage as far as a 4 wheel truck is concerned.

Mr. Lewis Kingman, C. E., stated that on the Atlantic and Pacific Railroad, the compensation $\frac{3}{100}$ per degree was adopted for all curves; that 10 degree curves were the maximum, and that all curves were eased off on both ends by compounding gradually from the tangent to the full degree of curvature. This practice he considered of great value and of very slight additional expense. From careful observations upon the action of locomotives pulling trains upon curves, it is his opinion that the compensation should vary with the grade.

Mr. A. M. Wellington, M. Am. Soc. C. E., said that the rule adopted by him was for the high grades the same as that of Mr. Morley, viz., $\frac{4}{10}$ per degree of curvature, but that Mr. Morley increased this to $\frac{6}{10}$ per degree on lower grades. The theory upon which this was done was formerly advocated by Mr. Wellington, but he now believes from further investigation, both experimental and theoretical, that no sensible difference exists due to the longer trains which could be run upon the lower grades. No absolutely fixed rate of compensation ought to be made. Circumstances of location may make it inexpedient to adopt a rate of compensation which otherwise might be desirable. The rate of compensation of $\frac{4}{10}$ per degree is higher than is ever necessary unless, in certain cases, at stations or where it may become a question whether to admit certain sharp curves at all. It is extremely probably that curve resistance is materially greater at very slow speeds. It is unfortunate that further and more complete experiments cannot be secured than have already been made.

Mr. M. N. Forney, M. Am. Soc. C. E., referred to the fact that the conditions of rolling stock and of track, were very important elements in any experiments that could be made upon this subject. Different car-builders made cars and trucks and wheels according to their individual notions. Engineers made the section of rail according to their individual notions. The actual condition of the rolling stock of the country was such that it was doubtful whether any experiments could be relied upon as determining results which could be applied generally.

Mr. Wellington expressed the opinion that while it was perfectly true that the condition of rolling stock was as stated by Mr. Forney, yet that experiment, properly made, could be relied upon to give fair average data.

The subject was further discussed by members present.

HUNTING CHOLERA.

The hunting of the cholera germ will always be one of the most interesting tales of science, and there now seems reason to believe that the quarry is fairly caught. That the "scourge of the East." and only in a less degree of the West, was caused by a minute parasite was matter of speculation before the modern germ theory was born. In the epidemic of 1854 some observers thought they saw this deadly organism. Last year Pasteur and Koch took up the search. Koch found in Egypt a microscopic object which he declared was characteristic of the disease. But he was unable to produce cholera by the suspected germs, and so the verdict was still "not proven." Undiscouraged he went to India. There in a water tank he found the tiny thing which had never before been seen outside of a cholera patient or his secretions. It was a great step. The argument from analogy was most convincing that the microbe caused the disease, but it was still possible that the parasite was only a sympton and effect of the disease and not itself the cause. A dispatch from Calcutta announces the taking of the final step. The animals which Koch fed upon the supposed cholera germ gave no sign that anything disagreed with them. But Dr. Vincent Richards, civil surgeon of Goalundo, caused the death of a pig from cholera within three hours after the poison was given. Even the caution of modern science must yield before such proof as this. The bearing of this discovery lies in the application of it, which is this: if cholera is one of the diseases caused by a parasite there is hope of the discovery of a vaccine or prophylactic. Then by attacking it in its jungle home the whole world may be saved. According to the usual rate and route of travel, cholera is not due in the United States until 1885, which completes the twelve-year cycle since the epidemic of 1873, and which is characteristic of cholera. Cholera has never yet crossed the Pacific. The growth of modern travels make it an interesting speculation whether an original case may not be soon expected in San Francisco.

SPARTANSBURG, S. C., has voted a subscription of $75,000, and Rutherford County has voted $100,000, to be applied in building a road from Shelby, by way of Rutherfordton, to Spartansburg. It is now announced that the Georgia Central Company, which owns the Augusta, Greenwood and Laurens Road, and the Carolina Central Company will meet in Charlotte, N. C. on April 11, to determine the question of aiding the building of the road.

STAKING OUT.

"What is that, mother?"
"The Rodman, my child.
His footsteps are weary, his accents are wild:
His hair, how disordered! his eyeballs, how blear!
And see where his necktie hangs under his ear."

"Rod up there! Hold her steady!! Go on down the hill!!!
7.8. Cut 2.2—No, begosh it's a fill.
Half the roadbed: 13 + the slope 1,1;
No, it's 1½ though, as sure as a gun.
Well, that makes—let's see—O! stick her in there.
It'll do. Perhaps the contractor will swear.
But no difference: We're the big dog in this fight.
No matter what's wrong, just swear it's all right.
A contractor don't know a beefstake from a bone.
Now pick up your tools, and let's pull out for home.

J. H. K. B.,
Laurel Hill Swamp Angel

—From the *S. P. R. R. Transit.*

CORRESPONDENCE.

UNDERGROUND WATER LINE.

Special Correspondence Engineering News.

AUGUSTA, GA., April 8, 1884.

EDITOR ENGINEERING NEWS.—I am desirous of ascertaining the depth of the *underground water line* of this city, with a view to laying agricultural tile in the ditch with the sewers, to take off this subsoil water, and for information for our Board of Health. Will some one of your readers instruct me how to proceed to get this *water line* and its fluctuations in dry and wet seasons. I thought of sinking a series of *holes* or shafts a small depth, say to water, and taking the surface of water in them monthly. We have a great many pumps or wells, probably they would be of some use. An immediate answer will greatly oblige.

Yours truly,
SUBSCRIBER.

[A series of driven tubular wells or perforated pipe of small diameter would probably best answer your purpose. Some of our subscribers may have a better method to suggest.—EDITOR ENGINEERING NEWS.]

CONSTRUCTION OF RACE COURSES.

Special Correspondence Engineering News.

HAVERHILL, MASS., Apr. 8, 1884.

EDITOR ENGINEERING NEWS.—In answer to some of the questions of your Baton Rouge correspondent, I find in one of my old note books the following, which was taken from an article on race courses published some years ago in the *Turf, Field and Farm*.

"HALF-MILE TRACK.—Lay off two parallel straight sides 600 ft. long and 452.36 ft. apart, connected at each end by a perfect semi-circle of 226.18 ft. radius. The above gives the extreme inside line. Curve of 25° 32'.

"MILE TRACK.—Lay off two parallel straight sides 1,320 ft. long, and 834.33 ft. apart, connected at each end by a perfect semi-circle of 417.17 ft. radius. (13° 46'). The above gives the extreme inside line. N. B. The true measurement of the mile or half-mile is 3 ft. from the inside fence."

While running a preliminary line for the Manchester and Keene R. R., in 1876, we found a half-mile track at Greenfield, N. H., laid out according to the above rule. It measured 25 ft. between fences on the straight portions, and 30 ft. at a point about half-way around each curve. Yours &c.,

JOHN T. DESMOND, C. E.

The Bursting Strain in Revolving Wheels.

Special Correspondence Engineering News.

PHILADELPHIA, PA., April 4th, 1884.

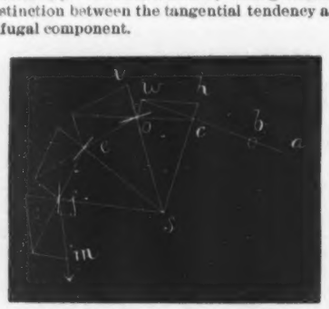
EDITOR ENGINEERING NEWS:

In the *American Machinist*, one of the handsomest of your mechanical contemporaries, appeared recently an article on "The Bursting Strain in Revolving Wheels"; the writer of which incidentally objects to the "Civil Engineers' Pocket Book's" definition of centrifugal force as "that with which a body while revolving around a center tends to fly off in a radius," claiming "that it is not true," and that the body has no such tendency; and he further denies the propriety of the term "centrifugal force," on the ground that what is usually so called "is not centrifugal, and is not a force."

Strangely enough, the writer proceeds to speak of "the force drawing the body towards the center" and says "the body resists this deflection" (which it can only do by exerting a "force") and "this resistance is necessarily in the opposite direction,' *(i. e. centrifugal)*; and further, "this force is exerted to burst a wheel of uniform section in the same manner precisely in which the force of steam is exerted to burst a cylindrical boiler." Thus the writer, while objecting to the expression "centrifugal force," shows clearly that he recognizes the existence of just such a force.

The secret of this writer's difficulty seems to lie in his further remark that "centrifugal force may then be properly defined as the tendency of a moving body to move in a direct line," meaning a *tangential* line: whereas, as I will try to show, it is only a *component* of that tendency. Indeed, the tangential tendency is so much the *more obvious* one (as in the case of drops of water flying from a grindstone, as quoted by the writer) that it is not surprising that even a person of his evident clearness of perception should unconsciously come to regard it as the *only* one, or at least to confound it with its less obvious, but no less real, centrifugal component.

The following will, I think, make clear the relation between the two forces, and show that "centrifugal force" is a perfectly correct, and most appropriate, term for the force to which it is applied; and that, so far from creating confusion (as claimed by the writer referred to) it *prevents* confusion by calling attention to the distinction between the tangential tendency and its centrifugal component.



Imagine a marble, *b*, moving in a straight line, *ac*. At *c* it is struck by a stick or other object moving toward *s* with a force *bc*, and the marble, instead of proceeding to *w*, goes to *o*. Here it strikes against a stationary wall (represented by the short, heavy line) tangential to a curve drawn from *s* with radius *sc* = *so*. The marble travels to *e*, strikes there a second wall, and goes to *f*, and so on.

Now on reaching each point, as *o*, its tendency, *co*, is tangential (or would be if the number of points were infinite, as in a circle); but this tangential tendency becomes *decomposed* into (1st) a new tangential tendency, *oe*, and (2d) a *centrifugal* tendency *oc*, or "tendency to fly off in a radius *so*." The wall at *o* prevents the marble from following the latter. The former carries it on to the next point *e*.

In the case of the apple and string, or in that of the revolving fly-wheel, the string, or the cohesion of spokes and rim, acts as an infinite series of walls, or as a circular wall; and each point in the circumference of the circle described becomes the scene of a resolution of force, where, as in the case of the marble, an old tangential tendency is resolved into a new tangential, and a centrifugal, one; the latter counteracted by the tensile strength of the string, or of the spokes and rim; the former urging the apple, or portion of rim, forward to the next point.

The writer in question contends that we should regard the apple as offering merely a passive resistance to the active pull of the string, which latter continually strives to deflect it from its tangential path, and that, strictly speaking, such a passive resistance should not be called "a force" but, even if we could admit the latter objection, it would not apply to the centrifugal tendency of the apple, for it is plain, from the above illustration, that if any such distinction is to be made, we should rather regard the *apple* as *acting*, and the *string* as passively *resisting*.

The writer in the "Machinist" further claims that if the body had a centrifugal (*i.e.* "a tendency to fly off in a radius") it ought to follow it when the string breaks: whereas we all know, that, as illustrated by drops of water from a grindstone, it flies off in a *tangent*. The answer to this apparently valid claim is that the centrifugal tendancy *ceases with the breaking of the string*. While the string holds, the centrifugal force of the apple, and the centripetal force exerted at any moment through the string, are equal to each other: and these two equal forces, pulling in apposite directions at the two ends of the string, produce a strain upon it equal in amount to one of them. If the velocity is increased, these two forces increase together until the strain equals the tensile strength of the string. The moment the strain exceeds the strength, the string breaks, the centrifugal and centripetal forces cease at the same instant, and the apple moves forward in a tangent, impelled by its tangential tendency, which is now the only force acting upon it. In other words, the apple is now in the position of the marble in the sketch after it has passed the last wall, at *f*. There is no further obstacle, to bring about a resolution of the tangential force *fw*; consequently there can be no further "tendency to fly off in a radius," and the body moves on in a tangent.

JOHN C. TRAUTWINE, JR.

THE OHIO FLOODS.

U. S. ENGINEER OFFICE,
No. 82 W. Third St., Cincinnati, O.
April 8th, 1884.

EDITOR ENGINEERING NEWS:—In your issue of the 5th inst., Mr. McElroy has a letter on Ohio River Floods, in which, without mentioning my name, he takes issue with my conclusion that these floods are practically uncontrollable, and intimates that I have decided the question "without survey," and on insufficient information.

In reply I will state that I did not advance any individual views on this matter, but adopted and circulated the opinions of my predecessor, the late W. Milnor Roberts, who had charge of the government work on the Ohio River from 1866 to 1870, and who was thoroughly familiar with Western Pennsylvania from the engineering practice of a life time devoted to the profession. I am forced to conclude that Mr. McElroy has not read the elaborate report from which I made a few extracts, and that he supposes it to be merely a crude and hasty generalization from insufficient data. I therefore beg that he will suspend his opinion until he has an opportunity to read the document in question. It was printed separately, as Executive Document No. 72, House of Representatives, 41st Congress, 3d Session, *and is not to be found in the Annual Report of the Chief of Engineers*.

If, after studying Mr. Roberts' report, Mr. McElroy wishes to discuss the matter further, I will hold myself at his service, but I do not care to spend time now in repeating what has been so well and exhaustively treated by my immediate predecessor in the work now under my charge.

The quotation which Mr. McElroy gives from the Report of the Chief of Engineers for 1873, refers to a project for improving the navigation of the Great Kanawha, which was thrown aside as soon as the improvement of this river was seriously undertaken. It is merely a preliminary *office* plan that failed to stand the searching examination instituted as soon as it became necessary to make a final decision, and to commence construction. The fact that it was immediately abandoned for the Great Kanawha, is a sufficient answer to the unwarranted assertion that the plan would have secured six feet for the Ohio below Point Pleasant. Such dams as the plan contemplated were wholly inadmissible on the Kanawha, and still more so on the Ohio.

I will only state in conclusion that the approved projects now in process of construction for the radical improvement of these two rivers are identical, except as affected by the differences in magnitude of the streams themselves, and of the commerce that floats on them.

Your obedient servant,
WM. E. MERRILL,
Lt. Col. Engineers.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E. : M. INST. C. E.

(*Continued from page 164*)

DCXVII. MOUNT MORRIS, N. Y.

Mount Morris, Livingston Co., New York, in lat. 42° 45' N. long. 78° W. is on high ground overlooking the valley of the Genesee. Settled in 1794, it was incorporated a village in 1830.

Water-works were built in 1879, by M. H. Mills, as a private enterprise, after plans of J. Nelson Tubbs, and under the direction of Byron Hawley. The water is taken from eight springs which crop out in an area of 30 acres of fine sand at the base of hills of sandy loam one mile west of the village. Around each spring a line of 5 inch horse shoe tile is laid, 3 feet under the surface, and 10 feet from the spring, conducting the water to small masonry wells 3 feet square and 6 feet deep, laid in cement mortar.

In these wells the quicksand, suspended in the water, settles, and is cleaned out once in three months. From these settling wells 2 inch wrought-iron pipes carry the water to a larger well, and thence it is conveyed by ¾ of a mile of 4 inch cast-iron pipe to a reservoir constructed in excavation and embankment, 125 feet square, and 12 feet deep, the bottom and inner slopes paved with stone, grouted and plastered with cement. There are supply and waste chambers of masonry, from the latter of which an 8 inch cast-iron pipe is carried under the reservoir, and then by a 4 inch pipe to a stream 70 feet below the reservoir. The flow line of the reservoir is 100 feet above the main street of the village. Distribution is by 5 miles of cast-iron pipe of 8 to 6 inches diameter with 26 fire hydrants, 19 gates, and 6 meters.

The number of taps is not given. The village pays $45 yearly for each hydrant. The daily consumption is 60,000 gallons. The population in 1880 was 1,899, it is now stated as 2,500.

DCXVIII. STE. CUNEGONDE, QUE.

Ste. Cunegonde, Quebec, in lat. 45° 25' N., long. 74°, W. a western suburb of Montreal is on the river St. Lawrence.

Settled in 1874, it was incorporated about 1876. Water-works were built in 1879 by Bergenaud Bélique, as a private enterprise, after plans of J. A. Y. Beaudry, C. E., the supply being taken from the river, which at this point is three miles wide, and flows with a velocity of 10 miles per hour.

A stone crib 75 feet long, 32 feet wide and 25 feet deep is built in the main channel of the river in water 23 feet in depth, having a chamber 6 feet square in the centre, provided with gates to control the supply. From this chamber a circular wooden flume of 3½ feet diameter,

constructed of red pine staves, 4 inches thick and 4 inches wide, nailed together every 4 inches with 3 inch copper nails, and having hoops of ½ inch iron, 3 inches wide bolted on every 4 feet, conducts the water 1964 feet to a well 8 feet in diameter, and 32 feet deep, laid in stone and cement, whence it is pumped by a quadruplex Holly steam pump directly into the mains, with an ordinary pressure of 50 lbs. and a fire pressure of 75 lbs. From these works water is also supplied to towns of St. Gabriel and St. Heim. Distribution is by 8¼ miles of cast-iron pipe of 12 to 4 inches diameter with 14 fire hydrants, 12 gates, and 1,100 taps. Seven meters are in use. Service pipes are of lead. The town pays $1,000 yearly for hydrants. The population in 1883 was 6,000, and the daily consumption 180,000 gallons. The cost of the work has been $125,000. C. F. Porlier is Secretary and Treasurer of the Works.

WATER.

THE Manistee, Mich., water is pronounced unfit for use, on chemical analysis.

AN appropriation of $3,500 has been made to sink an artesian well at Fort Sully, Dak.

SALEM, Ind., Water-works proposals will be opened this week. Reservoir system: 100 feet head. The engineer is Frank Schefold of New Albany, Ind.

THE Long Branch, N. J., Water Supply Company has contracted for improvements that will increase the water pressure in case of fire among the summer cottages.

AT a meeting of the taxpayers of Lawrence, Kan., held for the purpose of discussing the water-works question, a resolution was passed that the city council should buy another fire engine and build more cisterns and not erect water-works at present.

AFTER a year of "pottering," the Croton Aqueduct Commission on Wednesday declared the public hearing on the aqueduct closed, and by formal vote adopted the modified Hudson River route heretofore described.

THE Carrollton Water Company have elected the following officers for the first year: President, B. F. Jones, Kansas City, Mo.; Secretary, E. L. Martin; Treasurer, F. Wing; Engineer and Superintendent, J. L. Mitchell.

The company will build water works at Carrollton, Mo.

THE Judiciary Com. of the Mass. Legislature resumed the hearing, on April 7, of the meter question in Boston. Wm. F. Davis, water registrar in 1855, was the first witness, in the main he was opposed to household meters, said they would cost $.0 each, and after 30,000 cu. ft. of water had passed through them, would require in six months repairs to the extent of $3. to $5. He thought the Deacon waste detector would reduce the consumption from 40,000,000 to 28,000,000 gallons.

John Coleman, Mechanical Engineer of Providence, R. I., next testified, and advocated meters and ridiculed the Deacon detector: he admitted that he was incidentally connected with the Spooner Meter Company; he only wanted a fair test for that meter.

WORK was suspended at the city well, Lincoln, Neb., the 30th ult., to allow workmen to put in an additional pump for the purpose of keeping down the constantly increasing volume of water, and in a short time the water rose within six feet of high water mark. It is now estimated that the flow is about 100,000 gallons per hour, with five or six feet of clay yet to penetrate before the water producing strata is reached. It looks as though there would be no question of Lincoln's water supply for the next half century at least.

THE Biddeford and Saco, Me., Water Power Company, has completed arrangements with the Councils of those cities for the exclusive right to furnish water for domestic, fire and general purposes. The works, which will be completed by January 1, 1886, will consist of a pumping station, reservoir capable of containing 12,000,000 gallons, and a distributing system throughout the two cities. The water will be taken from the Saco River at a point about two miles above the city of Biddeford. It is expected that the company will expend about $175,000 upon the works this year, and that they will be rapidly pushed to completion.

IN the Massachusetts Legislature, the Committee on Water Supply heard President Burnham of the Revere Water Company in support of its petition for authority to add to its capital and its bonded debt whenever it supplies other towns with water. He said that the company draws 250 000 gallons of water daily from 13 artesian wells. The population of Revere is 2,500, while it has water enough for 4,000. The company is negotiating with Winthrop to supply that town with water; this will require an outlay of about $ 0,000. For supplying Revere, the company has expended $100,000, this expenditure covering the cost of pipes, pumps and reservoir. No opposition.

THE working force on the Council Bluffs, Iowa, waterworks has been cut down, which does not suit the eager citizens who want to see the work rushed.

HAVERHILL, April 5.—A petition has been presented to the city government, signed by twenty-five prominent citizens, asking that the authorities look into the affairs of the Haverhill Aqueduct Company. The petition claims that public interests demand that the city should control a water service of his own: therefore it asks that three commissioners be appointed to investigate the present company's manner of doing business, and, if necessary, to appraise the works for the purpose of transferring them into the city's hands. If such a plan should be considered unwise, it is requested that the city construct a water system of its own, independent of the present one. The petition was referred to a committee for future consideration. Very likely the committee will report unfavorably to the scheme, as the present city government is economically disposed, and the construction of new works or the purchase of those already existing would entail a large expense. The public feeling toward the present water company is most favorable. Its acts have been honorable and it has furnished the city with an abundant supply of good water for a long time. Recently a high service has been put in, and the advantages in case of fire are most important. The city would be a long time in bringing a new water system up to an equal grade of excellence.—Correspondence Boston *Globe*.

THE city of St. Joseph, Mo., has gone to considerable expense in the fitting up of a building for the purpose of testing water meters. A late series of tests were conducted under the direction of Maj. T. J. Chew, and in the presence of Thos. J. Whitman, Water Commissioners of St. Louis, for the purpose of ascertaining the least size of opening through which water would pass and still correctly register the quantity. With a hole ⅛ inch in diameter in the disc in the outlet pipe, all the meters tested, except the "Crown," practically failed to register; some of them would register, but the quantity indicated varied 15 to 20 per cent. from tank measurements. The "Crown" was then further tested on an opening only ⅛ inch in diameter, under the following conditions: Pressure on gauge, 135 lbs. per sq. inch: time, one hour and fifty-one minutes; quantity by meter, 1.65 cu. ft.; quantity by tank, 1.68 cu. ft. While this experiment was being made, the flow was stopped twice, the hole being "plugged" each time by a very minute stem of grass (which has been sent to this office). The disc was inserted in the outlet pipe, some distance from the meter.

The above test speaks very well for the "Crown" meter, and inasmuch as its manufacturers, the National Meter Company, have recently made an extensive increase of floor space in their factory to make room for new machinery, and are, notwithstanding, unable to keep pace with their orders, it is safe to say that the good qualities of this machine are fully appreciated by the meter-using public throughout the country. In our advertising columns, the National Meter Company announce the sale by them of over 20,000 meters to March 1st. The Company inform us that they are now making an average of 200 "Crown" meters per week, the sizes ranging from ½ inch to 6 inches inclusive. We are glad to note this as a gratifying indication of the growing popularity of the meter system.

THE Clyde, Ohio, water-works were officially tested on the 1st. The supply is taken from Raccoon Creek; the storage reservoir is largely of natural formation: the engines were supplied by the Gordon and Maxwell Mfg. Co. of Hamilton, O., and consist of one compound condensing, low pressure engine with a pumping capacity of 1,000,000 gallons each twenty-four hours, and is intended mainly for domestic supply; and one auxiliary engine (high pressure) of the same pumping capacity, which is intended specially for fire protection.

The reservoir, engine house, machinery and nearly 10,000 feet of pipe and 18 fire hydrants were purchased and laid for a sum total of about $22,000. The test, made before at least 3,000 people, was a perfect one, streams of water being thrown simultaneously from several hydrants through 100 feet of hose attached to each, to a height of from 120 to 150 feet, and was witnessed by the Mayors of several adjoining cities, and by a number of Civil Engineers.

CARDIFF (WALES) WATERWORKS EXTENSION.—The first sod of these important works was cut by the Mayor and Corporation of Cardiff on the 14th ult., when Mr. Bird, the present mayor, turned the first turf of the Llanishen Reservoir with a silver spade, presented to him by the engineer. This storage reservoir, which is situated four miles from Cardiff, and is capable of holding 300,000 000 gallons of water, is part of an extensive scheme for supplying Cardiff with water direct from Taff Fawr, on the Brecon Beacons. The total cost of the undertaking is estimated at £300,000, and includes a 24" gravitating main from Taff Fawr to Llanishen, the construction of compensation reservoirs on the line of route, and the storage reservoir at Llanishen. The works were designed by Mr. J. A. B. Williams, A.M.I.C.E., of Cardiff. The contract for Llanishen Reservoir is let to Messrs. Hill Brothers, of Beckenham, for £53,000. The contractors' engineer is Mr. J. C. Dudley, and the clerk of the works is Mr. J. T. Jones.—*Contract Journal.*

CANON CITY, Colo., April 1.—The water bonds were carried by a close vote. The election of city officers passed off quietly. The count is progressing slowly, and will not be officially declared until to-morrow morning.

PURE Water is the great necessity of life. The blood contains about 78 per cent. of water, and a large quantity must be taken to support the evaporation from the body. Any solid matter it contains, or any other impurity, not only finds its way to the blood very soon, but is concentrated there and very quickly causes disturbance. A striking instance of the effect of impure water is given by the fact that the water of the holy (?) well of Mecca, which is frequented by millions of pilgrims who camp around it, for the purpose of drinking from it, contains in each gallon 379 grains, or about 1¼ ounces of organic matter, and is seven times worse than the flow from the sewers of a great city. The consequence is that this poisonous filth produces that fatal disorder known as Asiatic cholera, which is carried by these pilgrims to their homes, where it spreads contagiously and has sometimes swept over the world. And this foul well is the first source of this disease. What a lesson is thus given of the evils of impure water caused by a want of ordinary sanitary provision.

THE Report of the Commissioners of the State Water Supply of New Jersey, has been received, embracing their examination into the capabilities of the Passaic River Basin, for the collection and storage of pure water for the use of the cities and towns dependent upon it for future supply.

The general plan, outlined in this report, proposes to furnishes water to the counties of Hudson, Essex and Union, and Patterson and Passaic, in Passaic county, in which district, 411,404 inhabitants now consume 37,331,000 gallons daily from existing water works.

The supply is to be obtained by the construction of a series of impounding reservoirs in the northern part of the Passaic Valley, where the water is exceptionally pure, building those reservoirs as the demand will warrant. The water is to be delivered at Montclair by an iron conduit, 6 feet in diameter, thence to the Jersey City reservoirs. The engineers of the commissioners, Messrs. L. B. Ward and Wm. E. Worthen, estimate that it would cost $2,007,600 to furnish 60,000,000 gallons daily, and that the quantity could be increased to 80,000,000 gallons by a further expenditure of $308,000, and to convey the water to Jersey City, $412,500, making a total of $2,728,100; the Commissioners add an additional 20 per cent. for contingencies, beyond those estimated by the engineers, and put the total amount, required to furnish the 80,000,000 gallons daily, at $3,273,720.

The report of the engineers describes, in detail, the location, area and relative heights above side of the different impounding reservoirs proposed, together with the calculated supply from each: the total storage capacity of the ten reservoirs and ponds is estimated at 12,920,000,000 gallons, equal to a supply of 60,000,000 gallons per day during the dryest season recorded By enlarging two of the above reservoirs and constructing two new ones, an additional supply of 11,000,000,000 can be obtained, giving 80,000,000 gallons per day.

The proposed conduit would be of wrought iron, ⅜ inch, 6 feet in diameter and protected inside and out by a coating of coal tar. It would be 16 miles long, delivering the water with an actual head 343 feet above side. Two years' time would be sufficient for the completion of the works, according to the engineers' estimate.

The engineers' report enters into the questions of compensation to mill owners, etc., and into the comparative economy of the proposed plan.

WE are indebted to Lucian R. Taylor, Water Commission of Worcester, Mass., for the annual report of the committee on water, for that city, for the year ending Nov. 30, 1883. The report is to be commended for giving data as to cost of the new pipe-line laid last year, not usual in documents of this character.

The length of this new pipe-line was 22,120 ft. divided into: 20 in., 4,316 ft.; 24 in., 10,714 ft.; 30 in., 7,090 ft. The pipe was let March 7, 1883, by contract with A. H. McNeal, of Burlington, N. J., at $35.85 per ton, delivered in Worcester. The hauling from cars to the line of work was let at $0.67 per ton. Work was commenced on May 1st, and completed Oct. 10, 1883. The cost of this pipe-line was as follows: For pipe and special castings, $23,271.26; valves and hydrants, $1,191.15; lead, $3,658.35; freight and trucking, $2,072.08; powder and fuse $209.27; labor (men), $37,359.80; transportation (men) $1,878.64; packing, fuel and cement, $244.49; travelling expenses, $142.87; engineering, $97.22; repairing sewer, $82.45; Total, $132,817.41.

The report includes an interesting and detailed report of Lucian A. Taylor, the engineer in charge of construction of the new dam and reservoir at Tatnuck Brook, describing the nature of the work, general dimensions and cost of execution.

We must make one remark however, which applies to other reports than that of Worcester, and that is the neglect to mention anywhere, on the cover, in imprint or within the book, the *State* in which Worcester is located. Last week we had a report from "Plymouth" which sinned in the same manner, there are many Worcesters and many Plymouths in these United States, and it is not always safe to guess which particular city or town is meant.

MR. C. C. THACHER and J. M. Webster were circulating a petition last week among the business men of Lawrence, Kan., to find the public sentiment concerning water works. The opinion seems to be about equally divided. C. C. Thacher is in New York *this* week.

THE Village Council of Loveland, O., some time since, spent considerable money putting down public wells, but as none of them are at present in working order, it is not known whether the wells contain oil or water. For several months the iron pump in front of the post-office has been disconnected, and is an obstacle to vehicles and pedestrians.

ON March 19th, bids were opened by the city council for the new water-works for Victoria, Texas. The bidders were, J. T. Jones, of Palestine, $38,000 cash or $41,250 city bonds; Galveston water-works Co., $39,000 cash, $43,000 bonds; Douglas & Heron, of Tyler, $39,250 cash, $41,750 bonds. The contract was awarded to Mr. Jones, who thinks he can complete the works by next September. Mr. M. L. Lynch, of Clifton, Texas, was the engineer for the city councils, and designed the works to be constructed; his preliminary estimate of cost, $40,265 was so near the accepted figures that complimentary resolutions were passed by the council, expressing their appreciation of his services and thanking him for "his patient and untiring efforts in their behalf."

WE have been publishing statements of the progress of the Lynn, Mass. Water Works Tunnel—taken from correspondence of the Boston *Journal*. We have the following of date 5th inst. which is authoritative:—"I notice in your publication of March 22, 1884, the following:—'More than 1,300 feet of the Lynn Water Works Tunnel are completed.' Allow me to correct you: the whole length of the tunnel to which you refer is to be but 1,358 feet, and the amount of heading driven to April 1st was 832 feet; 150 feet of which was in rock.

Yours truly,
W. C. BOYCE,
Engineer on Construction."

THE Board of Visitors of the University (Charlottesville, Va), have been in session for several days this week. The principal matter which engaged their attention was the subject of sewerage, water, etc. Engineer Bowditch, of Boston, was here in consultation, and the Mayor of Charlottesville, R. T. Harris, Esq., was also in attendance. The question of furnishing the University and the town with water conjointly is engaging the attention of the authorities of both corporations, and it is regarded as entirely feasible. Six thousand dollars is estimated as the maximum sum required to complete a system of works that shall insure an ample supply for both. The last General Assembly authorized the town of Charlottesville to borrow money for water-works, and it is thought the question of water supply will be put squarely before the people at an early day.—Richmond, Va., *Dispatch*, April. 5th.

ALBANY, April 8.—Mr. Van Cott's bill authorizing the formation of a company for furnishing salt water for fire and sanitary purposes in New York, was passed by 89 to 4. The commissioners of the sinking fund are empowered to contract with the company for this special water service upon such terms as they deem best, and are further given the privilege of purchasing the company's plant at any time within five years after the drawing of the contract, the cost to be decided by arbitrators appointed by the Supreme Court. The Howe bill, which permits the furnishing of water from bored wells, and which has been petitioned for by the dry goods district, is on the order of third reading.

Among the other bills passed were the following: An act appropriating $30,000 to improve the navigation of the Hudson River; act appointing the Mayor, Thomas B. Tweedle, and William H. Baker a commission to supervise the repavement of Fifth avenue from Washington square to Fifty-eight street, and authorizing the issuing of bonds not to exceed $600,000 therefor.

Mr. Daly and Mr. Robb opposed the latter bill, and offered various amendments, all of which were rejected, except that the sum to be raised was reduced from $600,000 to $500,000. It passed by a vote of 18 to 4.

THE Hyde Park, Mass., Water Company organized last Saturday evening with the choice of the following officers: President, Robert Bleakie; Clerk and Treasurer, Charles F. Allen; Directors, Robert Bleakie, Waldo F. Ward, John S. Bleakie, Benjamin F. Radford, William J. Stuart, David Perkins, Andrew Washburn. The company has not completed its plans, but it intends to begin work at once and hopes to have a supply of water for the town within a year. Ground will be broken first at the old gravel pit in the Corriganville District, where it is thought an unlimited supply of good pure water can be obtained. The place is in the valley formed by the Blue Hill water shed on one side and Fairmount Hill on the other. Competent engineers have examined the land and they report that water can be found at that place in sufficient quantity to supply the whole town. The territory formed by these water sheds includes an area of several square miles, and the drainage from this would seem to substantiate their theory. If water is found, the pumps will be located there and the standpipe will be placed on Fairmount Hill, the highest place in the town. Pipes will be laid in all the central streets and will be extended to all the outlying districts.

THE Eleventh Annual Report of the Water Commissioners of New Brunswick, N. J. is received. A three million steam and a two and a half million Worthington Power pump have been added to the works in the year, at a total cost of $25,570.68; they are reported as exceeding the contract speed, and as saving 47 per cent. in fuel over the old Selden pump. The average daily consumption of water for 1883, was 999,194 gallons. 77 meters are now in use. The receipts from water rents was $41,950.32, including $7,740 for fire and other city purposes; the total running expenses amounted to $11,233.99, divided as follows: General expenses, $5,877.04; Repairs, $1,256.83; Pumping, $4,100.12.

BOSTON, April 8.—William A. Simmons, Chairman of the Water Board, having accused D. B. Spooner, among others, with having attempted to bribe officials of the old Board to secure the adoption of the Spooner water meter by the city, that gentleman denied the charge, and asked Simmons to produce documentary evidence. Simmons, in reply, produces three documents with the signatures of Spooner, J. C. Watson, J. A. Hills, and other directors of the Water Meter Company, which were sent to a gentleman whose name is withheld. It was agreed in the first document to deliver to that person 1,900 shares of water meter stock if he obtained a city contract for 1,500 meters; the second paper is an agreement to pay a commission of $2 on each meter of the company's used by the city, and the third to deliver 300 shares of Spooner stock at one cent per share, provided the person induced the Water Board to adopt the Spooner meter as a standard, and procured orders from the Board for 1,000 meters. Hills and Spooner ask for a suspension of public judgment until they can make a statement of their side.—*N. Y. Sun.*

BOSTON, April 9.—In answer to the charges of Chairman Simmons, of the Water Board, that the Spooner Water meter Company used unlawful means to secure the adoption of their meter by the city, Messrs. Spooner and Hills, two Directors of the company, say that the documents presented by Simmons to support his charges of bribery, were given by them to James H. Fagin, who was employed by them as agent, and were simply in the nature of a pure business contract, such as they would have given any other man of similar business qualifications. Fagin was not at that time, nor at any time subsequent to the contract, a member of the city government, a city officer, or city employe. They deny utterly, and in a most emphatic manner, that they have in any way, directly or indirectly, attempted to improperly influence any city official to aid in procuring the adoption of their meter.

NEWS OF THE WEEK.

Gas and Electricity.

THE largest gas main in the world has been laid through Westminster. Its diameter is four feet, and more than 23 miles of this four feet main, in four diverging lines, have already been laid from the great gas works at Beckton, by Woolwich, the work having been begun ten years ago; but the gas company only began a month or two ago the work of continuing one of the lines of the great main from Horse-ferry road, Westminster, right through the heart of London, to Goswell-road, St. Luke's, where is the chief district station of the company. The section of main being laid will be 3½ miles long, which will make the length of the entire main from Beckton, on this route about 17½ miles.

A FLEXIBLE gas-tight joint for drain pipes has just been patented by General Hutchinson, of Bideford, England. It consists of a deep elastic or pliant gasket, placed within the tapering cylindrical socket of the pipe, into which the correspondingly-tapered spigot-end of the adjacent pipe is forced by a portable compressor. This compressor consists of a screwed rod, passing through a threaded bush, held in brackets fitted round one-half of the pipes, and retained by a chain passing round the other half. The screwed rod bears against a plate provided with radial projections, which in their turn bear against the end of the pipe. Suitable gearing is provided to give motion to the screwed rod.

Mining.

PITTSTON, April 3.—An unusually large body of coal was broken off to-day at the Barnum shaft of the Pennsylvania Coal Company. It was in one solid mass, and when broken up, filled ten mine cars. The mass of coal was blown off with thirty-two inches of powder in a sixteenth-inch drill hole. Old miners consider it a rare "shot."

SENATOR ECKLEY B. COXE writes to the Hazleton mine inspector that in case a person is killed in the mines of the Coxe Brothers, $50 is paid for funeral expenses, $3 a week to the widow, while unmarried, for one year, and for each child under 12, $1 a week until it reaches the age of 12. In case of accident, a miner is allowed $5 a week until he gets well, a boy, $2.50 per week.

As early as the sixteenth century, the Laxey mine on the Isle of Man, English Channel, was celebrated for its lead, copper and silver ores. The workings are more than 1,380 feet deep, and it takes the miners two hours to reach that depth. The ore obtained in a single fathom is frequently valued at $900, while the profits divided among the shareholders have reached the enormous sum of $150,000 per annum. The mines are kept clear of water by a very ingenious contrivance, the main point of which is an enormous water wheel, the measurements of which are: Diameter, 72ft. 6in.; circumference, 227ft. 9in.; breadth, 6ft.; length of iron shaft, 17ft.; diameter, 21in.; weight, 15 tons; length of crank, 5ft.; stroke, 10ft.; stroke of beam at mine pump, 8ft. If required, it will pump 250 gallons per minute from a depth of 500 yards and more if desired.—English Paper.

Streets, Drainage, Sewerage, Etc.

THE sewer system of Ocean Grove, N. J., is being extended through Atlantic-ave.

SEVERAL artesian wells have been sunk at Key East, N, J., Pure and wholesome water is found at a depth of fifty feet.

THE new sewerage system of Atlantic City will not be completed in time for use the coming season.

THE Newport, R. I., City Council has adopted a system of sewerage, and appropriated $20,000 to commence the work. The plan is a modification of that of E. S. Chesbrough, of Chicago. The outlet is through land of the Old Colony to the outer harbor.

CITY Works Commissioner Fleeman, has awarded the contract for cleaning the streets of Brooklyn, for the next three years to Henry Beran, whose figures were $143,000 for the first, $144,000 for the second, and $147,000 for the third year.

THE City Committee on Sewerage of Brockton, Mass., have unanimously agreed to recommend the adoption of the plans submitted by the special committee chosen by the town in 1880, embracing the suggestions made by Engineer Phineas Ball of Worcester, after a careful survey of the place. The recommendations are as follows: While your committee appreciate the magnitude of the subject, they are of the opinion that immediate action should be taken to relieve the most dangerous and most unhealthy portion of our town, and they would recommend that the following sewers be constructed the ensuing year; Commencing at the foot of Court street on Montello, thence running south into Salisbury Brook below Packard's mill; then commencing at Montello, run west through Centre to Main; thence South to Alton street, then west about 130 feet. Commencing at Montello, run west through Lincoln to Main; making about 4000 feet of sewer (to be used only for surface water for the present) together with 10 catch-basins and 15 man-holes. From careful estimates we believe this can be done for $10,000, and we recommend that this sum be appropriated for the current year, this amount to be raised by a temporary loan, and be included in the taxes assessed in 1885. We then have made a move in the right direction, and we suggest that an appropriation be made each year till the whole system is completed. We would also suggest that some action be taken to establish the several natural water courses in the most thickly settled portions of our town.

THE discharge of sewerage into the Mystic lower basin continues to create a nuisance, if it is not a menace, to the health of the people residing in the vicinity. Costly experiments and continued pumping deplete the revenue of the Water Department of the city without materially changing the character of the sewage. The settling tanks, the Farquhar filter, the "meadow-hay" scheme, etc., could not under the most favorable conditions remove the soluble matter from the sewage, and as this represents from six-sevenths to seven-eighths of the value for fertilizing purposes, and nearly the same proportion of putrescible matter, any system which is not calculated to eliminate the soluble matter, must prove a failure.

The settling tanks take out a portion of the solid matter in mechanical suspension, composed chiefly of tan bark, hairs and a small amount of other debris from the tan yards, which, after being dried, is not considered by the farmers worth carting for a gift. All the coloring and soluble matter passes through the tanks into the shallow ditch lined with an impervious skin of deposit, and finally into the pond without change, except that by thus exposing it to heat, light and air, its putrefaction in the basin is more certain and rapid. The filter could accomplish but little more. Chemists do not expect the strength of a solution or decoction is diminished even by the most careful filtration. Sewage may be clarified by passing through a filter, but it is a physical impossibility to thus extract soluble matter unless it be run sufficiently slow for the in-

fusoria and oxidation to eliminate the matter while in transit.

Treatment by chemical agents promises no better results. At Birmingham 27,900 pounds of lime is used each day to precipitate the material in 12,000,000 gallons of sewage. The "sludge" together with the lime amounts to 360 cubic yards each day, and is of so worthless a character no one will take it away for a gift. Dr. Frankland wrote in 1881: "The actual resources of chemistry do not permit the hope that the dissolved polluting matter in sewage can be precipitated by any appliance of chemical reaction, and unless new chemical laws are discovered it is useless to attempt the employment of such agents for the epuration of sewage."

There are two methods of treating the sewage of the Mystic Valley. One comparatively inexpensive and promising partial success, the other more costly, but assuring complete epuration.

By spreading the sewage alternally on large areas of permeable soil, and known as "downward intermittent filtration," the sewage may be purified sufficiently to permit its discharge into the lower basin. I. Bailey Denton has constructed such a system at Abingdon, Great Malvern, Halstead, Eng., and Farfar, Scot., with satisfactory results.

The other system, known as irrigation and agriculture, would require the purchase of additional land to be put in a state of cultivation and a somewhat complicated system of drainage, but from which a return might be anticipated, either from renting the land or sale of crops. Italian rye grass will take up the greatest amount of sewage, and ozier beds next the pond would insure complete epuration. *Cor. Boston Journal.*

Contracting Miscellany.

TROY, O., is to have the new Court house, so long fought for. Cost, $150,000.

ENGINEERS AND CONTRACTORS.—In a leading article in last week's *Engineer* we read:—"Contractors frequently complain of the difficulties they experience in getting value for work to be executed. Virtually the question of profit or loss on a contract depends upon the character of the engineer under whom the work has to be carried out. Sound workmanship can be done at a certain cost, but the amount of finish demanded has a great influence upon the expense involved." Contractors will probably remark, "Why, cert'nly,"

MADISON, Ind., April 4.—At a meeting of the stock-holders of the Eagle Cotton Mills and our citizens last night, the contract between O. M. Harker, President of the Eagle and Banner Cotton Mills, of Pittsburg, and the directors of the Eadison Company was ratified, thus securing Madison the much talked of cotton mill. The capital stock is $250,000. Suitable buildings will be erected and the plant removed to this city, giving employment to five hundred hands. O. M. Harper retains the Presidency.

Bridges.

NASHVILLE, Tenn., April 3.—The bill favorably reported by the Senate, to-day, giving the assent of the Government to the construction of a free bridge across the Cumberland River at Nashville, applies to the iron structure to be erected near the race-course by the Cincinnati, Green River and Nashville Railroad Company. The bridge will cost $300,000, and will be commenced soon after the city subscribes to $500,000 first mortgage bonds, a large part of which has already been secured.

THE Balt. & Ohio Bridge across the Susquehanna, at Havre de Grace, Md., was let to the Keystone Bridge Co. on March 29th, for the following spans:—One 520 ft. through span, one 520 ft. deck span, four 480 ft. deck, two 380 ft. deck, one 380 ft. through, one 200 ft. deck. 2,000 lin. ft. of viaduct about 70 ft. high will be built by the B. & O. Co. Gen. Wm. Sooy Smith of Chicago, has the contract for the subfoundations, and Drake & Magaw of New York, the contract for masonry.

Railroads, and Canals.

THE Richmond, Va. & Chesapeake R. R. Co., organzied last week at a meeting held in the office of Mr. H. A. Atkinson, Richmond, Va.

SOME of the most substantial business men are interested in this road, which will run from that city to a point on the Potomac river near its mouth, about seventy miles, and passing through a section of Virginia which is now entirely isolated from the Richmond markets.

AN estimate submitted to the Canadian Parliament on April 9.h, calls for $70,000 to pay the expenses of an expedition, by water, to Hudson Bay, to test the practicability of the route for commercial purposes.

ALFRED F. SEARS, C. E. has recommended, in a careful and elaborate report, a sewerage system for the City of Portland, Oregon. He advocates the separate system as best adapted to the local requirements. He estimates the total cost at $348,958.

A ZACATECAS paper stoutly alleges that the Mexican trunk railroads are being built mainly to facilitate the work of conquest, and that the fellow-countrymen of Gen. Taylor and Gen. Scott need only the opportunity to gobble up Mexico as the buzzard does a worm.

THE railroad built three years ago, from Farmington to Phillips, intended to open up the Rangeley Lake region in Maine, is a two-foot gauge, and despite the original doubt on that head, has been operated successfully. It has been used for lumbering and general travel, and several other narrow-gauge lines, some forty miles in total length, are now projected in the same region.

PITTSBURG, April 5.—A dispatch from New-Castle says that Sheriff Davis, of Lawrence County, has advertised for sale at the courthouse the tracks, trucks, cars and franchise of the Erie and Pittsburg Railroad, from New-Castle to Erie, through the counties of Lawrence, Mercer, Mitchell, who recently obtained a judgment against the Erie and Pittsburg Road and ordered a foreclosure. April 11th, matter has been settled.

DES MOINES, Iowa, April 5.—A broad-gauge railroad is to be built from Des Moines to St. Joseph, Mo., a distance of 185 miles, in the present year by a New York syndicate represented by R. T. Wilson & Co. and B. L. Harding, of Des Moines, the latter being president of the company.

The roads which have passed into the hands of Receivers since midnight. Dec. 31, 1883, are: 1, New York and New England; 2, Hastings and Grand Island; 3, Texas and St. Louis; 4, North River Construction; 5, Connotton Valley; 6, St. Louis, Hannibal and Keokuk; 7, Cleveland, Youngstown and Pittsburg; 8, Shenango and Alleghany; 9, International, Interoceanic and Oriental; 10, Midland and North Carolina; 11, Portland and Ogdensburg; 12, Newcastle and Northern

THE Wisconsin Central Company on the 26th inst. let to Wells, Harrison & Green of Chicago, the contract for building the line between Chippewa Falls and St. Paul, a distance of 100 miles. The work is mostly heavy, and is to be finished this year. This company has heretofore depended on the St. Paul and Omaha for a connection with St. Paul. This extension makes more probable the old story that the Wisconsin Central will extend its southern end to Chicago.

THE incorporators of the Richmond, Va., and Chesterfield Railroad Company have organized. Judge R. H. Jones was elected chairman of the Board of Directors; T. B. Biddle, secretary and treasurer; Dr. T. B. Dorsett, superintendent, and A. Langstaff Johnston, 507 N. 9th street, Richmond, Va., chief engineer. The road will run from the city of Petersburg, through Chesterfield county, to Exeter Mills. The route will be located some time during this month, and the contractors will begin work early in May.

C. P. HUNTINGTON returned to New York last Saturday morning after an extended trip through the south-west. He was accompanied by members of his family and his private secretary. He visited Memphis, New Orleans, Galveston and Mexico, and inspected the various railroads in that part of the country in which he is interested. The extension of the Chesapeake and Ohio Railroad, now in course of construction between Memphis and New Orleans, is reported to be going ahead steadily. On the road between New Orleans and Baton Rouge a distance of 90 miles has been completed, and different portions of the line south of Memphis are finished but not connected. It is expected that the new road will be ready for traffic by the 1st of next September.

OTTAWA, Ontario, April 9.—The official statistics show that 1,275 miles of railway were built in Canada last year, making a total of 8.805 miles under traffic, and when the lines at present under construction are completed, which will be within two years, the railway system of Canada will comprise over 11,400 miles. The paid-up capital was increased to $494,271,264, or 19 per cent. The gross amount of freight carried during the year was 13,266,255 tons, the gross receipts for which were $21,320,208. The number of passengers carried was 9,699,984. The gross receipts, together with those for mails and sundries, were $11,924.377, making the gross revenue $33,244,585, an increase in receipts over those of the preceding year of $4,216,756. The net earnings for the year were $8,552,928, an increase of nearly $2,000,000. There were 169 persons killed, against 147 in the preceding year, and 550 persons injured, against 392 the year before.

PRUSSIAN railway employes are not magnates in point of income. The lowest average salary paid railway employes in America amounts to $384, while the average yearly pay of the 157,531 employes on the 9,001 miles of Prussian railways in '82-83 was $195. In their poverty, however, they have their pleasures. The Minister of Public Works has given notice that His Imperial Majesty has approved a change in the uniform of roadmasters substituting black velvet for the black cloth collars and cuffs heretofore used and a wheel and compass on the gold-laced collar, in addition to the two stars with which it has heretofore been ornamented.

WHEELING, West Va., April 9.—A certificate incorporating the Coal and Iron Railroad of West Virginia was sent to the Secretary of State, at Wheeling to-day. The incorporators are ex-Senator H. G. Davis, John A. Hambleton, of Baltimore; William Keyser, ex-Vice-President of the Baltimore and Ohio Railroad; Harrison Garrett, son of John W. Garrett, President of the Baltimore and Ohio; Senator A. P. Gorman, of Maryland; ex-United States Senator Chaffee, Enoch Pratt, a Baltimore millonaire; ex-Gov. Whyte, of Maryland; James G. Blaine, Senator W. Camden, of West Virginia; Senator Bayard, of Delaware; Senator John R. McPherson, of New Jersey, and other well known bankers and politicians. The road is to run from Winchester, Va., through Hardy and Grant Counties to Davis, Tucker County, about 40 miles south of this place, where it will connect with the West Virginia Central and Pittsburg Railroad, opening up one of the richest coal-fields in the world. It will be pushed to immediate completion. The capital of the new road is $4,500,000.

JOHN P. WATSON, of Philadelphia, who is largely interested in the railways of Pennsylvania recently said: "Railway building is going to be unusually active and extensive in all parts of the State. The Pennsylvania Railroad Company is going to parallel a good part of the main stem of the Philadelphia and Reading in the east, and in the west will probably extend the Ebensburg branch to the borough of Indiana, and build its south-west line on from Fairchance to Fairmount, West Va., this year. Work on four of the seven large tunnels on the South Pennsylvania or Vanderbilt line is now advancing rapidly and satisfactorily, and as soon as the roads permit the hauling of men and material the contractors on various sections of the road will begin operations.

"The Atlantic and Western Railroad Company, which contemplates the construction of a road on as nearly an air line as possible from New York through New Jersey and Pennsylvania and on to Chicago, has established its headquarters at Lewiston, and has a large corps of engineers running lines in this State, which the road enters at the Delaware Water Gap. This will parallel a good part of the Pennsylvania line, but will reach Hollidaysburg along the Juniata Valley, and cross the Alleghany Mountains at about the same grade as the old Portage Road, which is better than the route of the Pennsylvania.

"The Vanderbilt line from Lock Haven southward, the Pine Creek and Jersey shore, will also be built this year and give an outlet to the vast timber and coal interests of the Snowshoe region.

THE Nebraska Central R. R. Co., has been incorporated. The route starts at Mapleton, Iowa, and crosses the Missouri river into Nebraska at Decatur, thence traversing the State in a westerly direction midway between the Sioux City and Pacific and the Union Pacific Roads to the Wyoming boundary. The capital stock is $15,000,000, of which $1,500,000 is already paid up. The route and relations of the road outside this State are not yet learned, but there is considerable reason to believe that its projectors are bound to make it part of a transcentinental line, and that if necessary they will have any amount of backing. Messrs. Henry Franklin Shearman and Graham Lawson, two members of the English Railway and Canal Building Company, have been in Omaha in conference with the projectors of the road. The officers are L. Crounse, Fort Calhoun, President; R, F. Stephenson, West Point, Vice President; A. Ewald, Oakland, Treasurer, all of Neb., and a Board of Directors composed of capitalists from the various towns in this section. It is understood that the project is fostered by the Chicago, Milwaukee and St. Paul Company, and that the design is to give them a through line from Chicago to the Pacific coast. Surveyors will commence work at once and the contracts are to be let within sixty days.

It seems to be definitely determined that the D. L. & W. R. R. Co. will commence the extension of their road, from Buffalo to Chicago this coming summer. Surveys will soon commence. The Chief Engineer is Jas. Archbald, Scranton, Pa.

Some idea of the immense business done by the elevated roads in New York City may be gathered from the fact that on March 29 they carried 306,209 passengers and received $21,004 in fares.

It is estimated that there are 418,957 railway employes in America. It is the common mistaken impression that a position in railway service means a large salary, but the average income of the above large army is but $41.12. The lowest average compensation is paid on C. B. & Q., viz.: $32, and the highest on the Central Pacific $68.21.

The Northwestern Improvement Company, Astor House, New York City, has obtained the control of the Mississippi & Tennessee R. R., 160 miles long between Memphis and Grenada, R. T. Wilson is the heavy man of the concern, and he is also President of the southern branch of the Louisville, New Orleans and Texas Railroad, which branch is being built by the Nortwestern Improvement Company. The price paid was 66⅔ cents on the dollar for the interest of the McComb heirs, valued at $450,000. No change is to be made in the present management.

Denver, Col., April 8.—At the annual meeting of the Colorado Coal & Iron Company, at Colorado Springs to-day, the following nine Directors were elected: A. H. Danforth, John H. Small, Henry E. Sprague, W. B. Lawrence, J. E. Devlin, A. Rutton, W. A. Dick, Coleman Benedict, and Thomas F. Ryan. The Palmer faction represented 31,000, and the anti-Palmer 56,900 shares of the total of 100,000. Henry Sprague will probably be chosen President.

The London *Economist* is the authority for the statement that the Pennsylvania Railroad Company controls the largest income of any joint stock company in the world. The greatest English company—the London and Northwestern Railway—last year earned a gross $53,500,000, or, including "controlled undertakings," possibly $60,000,000, while on the Continent the most important line—the Paris, Lyons and Mediterranean—earned a gross $70,000,000. Such figures are a long way short of the Pennsylvania receipts, which exceeded last year $100,000,000.

The St. Paul and St. Croix Railroad Company has filed articles of incorporation in the office of the Secretary of State. With an office in St. Paul and a capital stock of $480,000, in 4800 shares of par hundreds, highest limit of liability to be $1,500,000 it will construct or hire, and operate lines of railroad from St. Paul through Ramsey and Washington Counties to some point on the eastern boundary of Minnesota. The names of the members of the company are Howard Morris of Milwaukee, Henry B. Wenzell, Brigham Bliss, Edwin A. Jaggard and Wm. H. Lightner of St. Paul, who will constitute the first Board of Directors. It commenced April 4, and will continue indefinitely.

Railroad Ties.—"I saw," said a contractor who handles a large number of ties in this locality annually, "that the *Herald* recently predicted that the time was approaching when red wood ties would have to be used on railroads. I am not in favor of red wood. While out West two or three years ago I examined this red wood and was convinced that it was too soft. In time a rail cuts down into even an oak tie and a spike draws out of it, hence, you can see that it would be an objectionable wood. Georgia pine, which is much harder than other varieties of pine, is preferable to red wood by far. Of course, if all the ties being laid were of oak the supply of that timber would soon give out. It ought at the present rate of consumption to last several years, however. The Nickel Plate is laid with many beech and maple ties. Beech is by no means a poor wood for railway sleepers."—*Cleveland Herald.*

Experiments are about to be made in San Francisco, Cal., with a new method of using compressed air for the propulsion of street cars. Instead of taking the air at each end of the line, as in previous experiments, it is proposed to run a four-inch main the whole length of the tracks, with attachments not more than a block apart, by means of which the reservoirs on the cars can be recharged. This will entirely avoid the danger of exhausting the motive power before reaching the end of the route, and also the pressure can be maintained at a high point throughout the trip.

An order has been given by the Richmond and Danville Company for 27,000 tons of steel rails, from mills in England to be furnished as fast as made. This amount of rail will be laid between Washington and Atlanta, and also on 80 miles of the Western North Carolina Road. The Maryland Legislature has authorized a loan of $2,000,000 to the Richmond and Danville Company, and it is intended to make direct connection with Baltimore and Atlanta over the Baltimore and Ohio Road, and a new bridge across the Potomac River is to be built, to prevent change of cars and breakage of bulk at Washington.

Galveston, Texas., April 3.—A special to the *News* from Dallas says: "A largely attended mass-meeting of citizens was held last night. The Committee on Public Benefit submitted a long report, the main feature of which was to have all property within three miles of the Court-house assessed 2 per cent. as voluntary contributions for railroad subsidies. One hundred thousand dollars was guaranteed to the first company building 100 miles of standard gauge railroad south-westerly toward Brownwood, and also similar sums for 100 miles of road to the north-west and to the north-east. A committee was appointed to confer with t e Denver, New Orleans and the Gulf, Colorado Santa Fé Railroad Companies. A delegation was present from Cleburne asking that that city be counted in to aid any movement from Dallas toward Brownwood."

Uniontown, Pa., April 3.—Competition is becoming very active over the proposed construction of the two rival railroads from Uniontown into West Virginia. The roads are known as the West Virginia and Pennsylvania and the Fairmont, Morgantown and Pittsburg, but they are really branches of the old rival roads, the Pennsylvania and the Baltimore and Ohio respectively. Officials of the latter company were here yesterday looking after the extension south of Uniontown, which is the present Southern terminus of that road. Nearly all the rights of way have been secured between the State line and Fairmont, where the branch will strike the main line, and it is said the road will be put under contract as soon as the weather becomes good. The West Virginia and Pennsylvania, which is the virtual extension of the Southwest Pennsylvania, will run from Uniontown to Clarksburg, by way of Morgantown and Fairmont, and will be a direct rival of the Baltimore and Ohio.

Commissioner Hauser estimates that railroad building in Wisconsin this year will equal 1871, when 418 miles were added to the roads of the State. The probable additions are the extension of Alma and Northern, a tributary of Burlington and Quincy, to Prescott, 160 miles; Wisconsin Central's line from Chippewa Falls to St. Paul, seventy miles; Northwest's connection between Valley Junction and Princeton, ninety-five miles; sixty miles of the new road from Minneapolis to Sault Ste. Marie; Northern Pacific Line from Superior to Ashland; Milwaukee and Northern's extension to the State line, and the Omaha Line from Neillsville to Wausau.

The *Railway Age* says that it is already safe to assert that there will be a large amount of railway building in the United States during the present year. While the number of great trunk lines to be completed or commenced is not likely to be so large as in the past few years, the demand for new and comparatively short roads for local accommodation and for extensions of existing roads seem to be as active as ever. The cost of construction has decreased greatly in recent years. The difference between the cost of steel rails in 1868 and 1883 was $11,170 per mile, equivalent to a yearly difference in interest at 6 per cent of $670 per mile each year. The saving in railway construction last year over the average price of 1868 was over $72,000,000.

IRON, METAL AND COAL MARKETS.

Philadelphia, April 10, 1884.

Very little change has taken place in the Iron trade during the past six days; demand in several directions is a little more active, but prices are far from satisfactory: Pig Iron is selling to a greater extent than for previous weeks, but it is difficult to place large lots as consumers still anticipate lower prices, and will not buy largely excepting at concessions, which, for the better makes, are not to be had. $20@$19 continue to be the average prices for good No. 1 and No. 2 Foundry, although the best brands are still firmly held at old figures. Gray Forge is selling slowly, and $16 is the asking price for the brands most wanted. Several kinds of cheap Iron are offered as low down as $17. $20 is offered for Bessemer Iron, and no sales can be reported; Spiegeleisen, $29; Steel Rails are nominally $34@$34.50 at mill, and these figures are paid for small lots; it is probable that business will be done this week at $33.50 for some good sized lots, but buyers are very indifferent, and makers are not yet short of orders. Manufactured Iron is selling freely in small lots, but large requirements are still withheld; Plate, Tank, and Structural Iron are moving about as usual, at prices which are firm for small lots, but shaded on desirable orders. Some of the Bridge Iron contracts, which were hoped for at Eastern mills, have been secured by Pittsburg concerns. There are large requirements for all kinds of Construction Iron, Nails, Sheet, and Wrought Pipe, and these will be presented within a month, but demand of every description is very backward. Nails are quoted at $2.50@$2.60; Old Rails have sold during the week at about $22, and would sell in larger lots at $21.50. The market generally is dull and quiet, and no improvement is possible until the weather settles, and buyers show more confidence in prices.

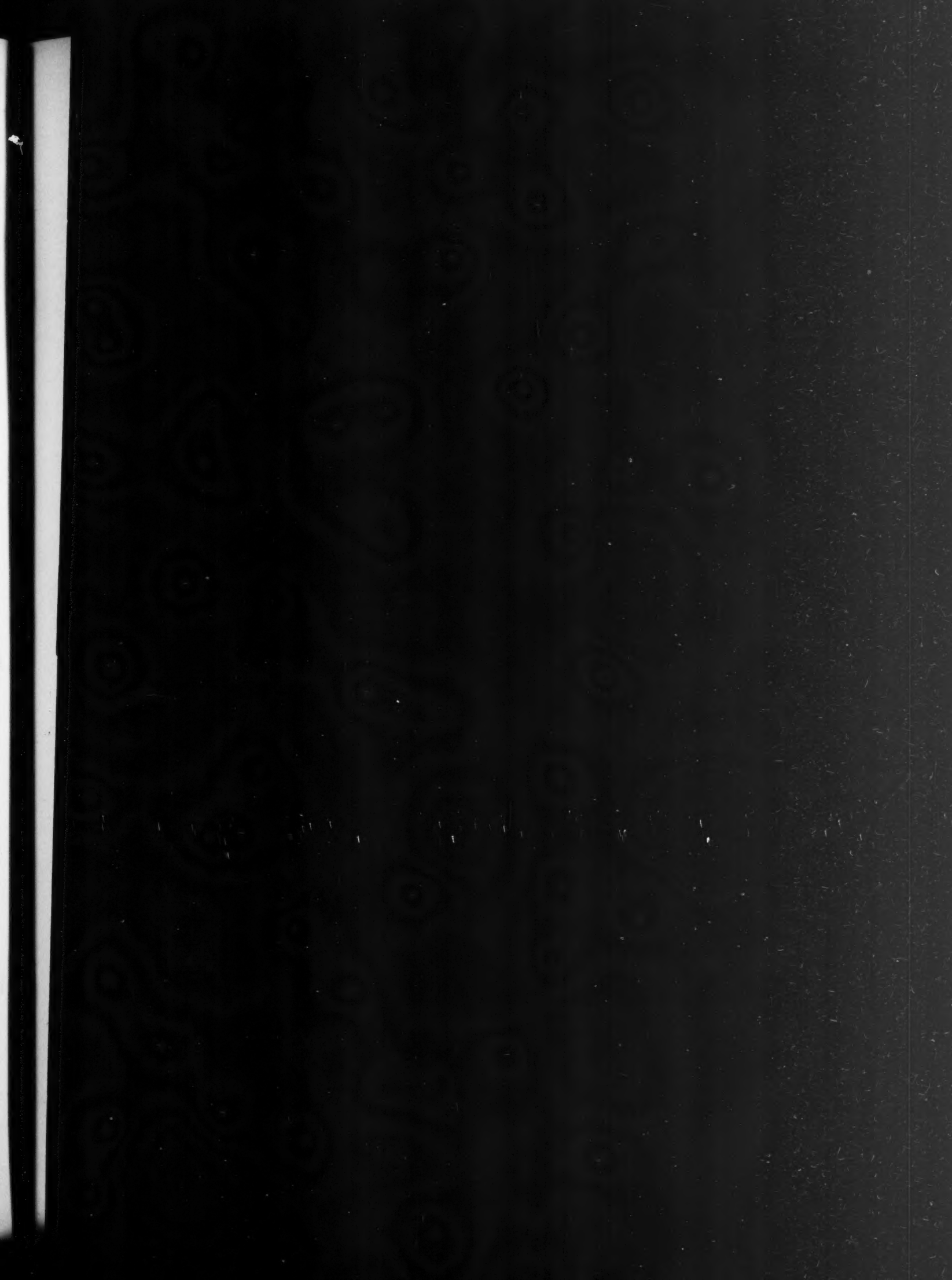
Pittsburgh, April 10, 1884.

Mill and Foundry irons are in very light demand, and prices are unchanged at about $17@$18 for Mill, and $19@$20 for No. 1 Foundry Irons. No. 2 is slow of sale, and may be quoted at $18@$19. Bessemer Iron is selling in small lots for Foundry use, at about $2.50. Muck Bar has sold mostly at about $31, with more asked for best makes. Carnegies Structural Mill has secured an order for about 6,000 tons of Bridge Iron for the B. and O. Railroad Company. Old Rails have been bought in the East at $23, and delivered here; sales have been closed at $23.50@$24 for small lots. The Wrought Pipe manufacturers are holding to their card, and report demand slightly better, although far below expectations. Steel Rails are quiet, at $35 nominally; Railway Materials is in moderate demand at old prices. The reduction at the Republic Iron Works has been accepted. The miners along the Monongahela have generally accepted the reductions, and work is going on as usual; it is generally believed here that the scale question will be settled without any trouble, but if there are any concessions to be made, the workmen will not be the ones to make them; they are determined to insist upon the continuance of the present scale. The date of the conference between them and their employers has not yet been announced, but it will occur sometime in the latter part of May. The experiments in Steel making by the new process at Oliver Bros. & Phillips, have proved successful. The regular monthly meeting of the Western Window Glass Association was held on the 7th, but nothing of importance was done. The demand for Window Glass falls far below anticipations, and the cutting of prices is Western cities is having a discouraging effect upon the trade.

Chicago, April 10, 1884.

The demand for Bar Iron shows no material improvement this week, and prices have not improved, being still quoted on a basis of $1.90@$2.00 for Refined. Structural and Plate Iron are in better demand, and the movement in Sheet Iron is a little more active. There are no changes in quotations. Mills on Galvanized Iron are receiving only light orders and prices are consequently unsteady. The demand for Foreign Irons is steadily declining, owing to the substitution for Domestic products. The local demand for Tin Plates is somewhat better. Stamped Tin Ware is moving freely, for country trade. Very little can be said as to Steel Rails: $36@$37 is still quoted, but neither buyers nor sellers seem very anxious for business to be done, and very few sales can be reported. Prices are believed to have a strong downward tendency however. The movement of Steel is without interest, though spring demand, if it is ever presented, is expected to be good. Nails are weak and are offered at $2.40 for large lots, without much business resulting. The ore Market is very quiet; there is a satisfactory movement in Hardware. Barbed Wire is active and steady; all kinds of Farm and Gardening Tools are selling freely; Heavy Hardware and Railroad Supplies are moving more actively, and a little firmer as to price. Pig Iron is in slow demand; Brier Hill Irons have declined to $22.50; Southern Irons continue in high favor here.

COAL.

Philadelphia, April 10, 1884.

The Anthracite companies are full of hope, and state that the position of the trade is very satisfactory to them, but, nevertheless, trade is dull and quiet for this time of year, and large buyers are holding off; prices are a great deal lower than last year, but it is generally believed that they will decline still lower under full time, and those who have heavy contracts to place are waiting to take advantage of such a decline, should it come, feeling sure that even if they gain nothing by delay, they will lose nothing, as prices cannot advance. Western demand will probably open up in a week or two, and this is looked forward to, as likely to help the demand very materially. Southern and Eeastern consumers are sending in their inquiries, which indicate that large stocks will be wanted in both sections. Stocks here are about 100,000 tons; the Clearfield miners are still at work, but there are strong probabilities of serious trouble in that region. The production of Bituminous Coal is increasing week by week, and some heavy contracts have been placed. There is still a great deal of discontent in the Anthracite region, but no outbreak is likely for the present, at least.